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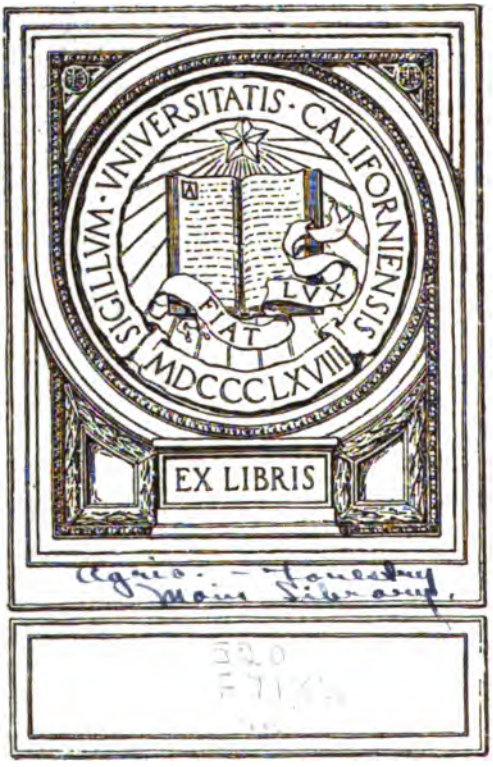
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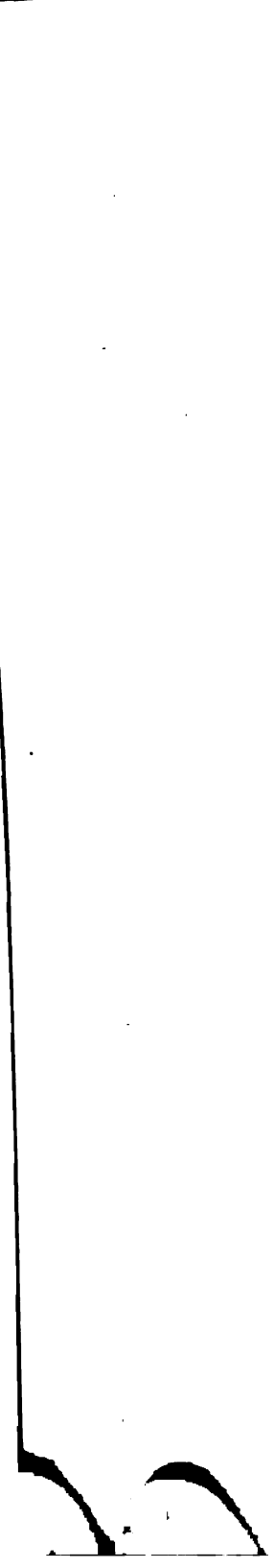

FORESTRY PAMPHLETS
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Walter Mulford
1889

DEPARTMENT OF AGRICULTURE.

PRELIMINARY REPORT

ON

Walter Mulford

THE FORESTRY

OF THE

MISSISSIPPI VALLEY,

AND

TREE PLANTING ON THE PLAINS.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
7465 1883.

LETTER OF TRANSMITTAL.

TOPEKA, KANS., *November* 16, 1882.

Hon. GEORGE B. LORING,
Commissioner of Agriculture:

SIR: The terms of the commission issued to the undersigned, bearing date July 25, 1882, instruct him to investigate and report upon the "forestry and forestry necessities of the States and Territories of the Mississippi Valley and east of the Rocky Mountains." In the limited time allowed for the preparation of this preliminary report the attempt has been made to ascertain the conditions and necessities of the country west of the Mississippi and east of the Rocky Mountains.

In the preparation of this report the writer has recognized the duty of addressing himself not to special classes, as scientists or professional arboriculturists, but to "all whom it may concern," to the end that every man who owns his "rood of ground" may become interested in the subject of tree-growing, and so co-operate in carrying out the purpose for which the bureau of forestry was established.

For the convenience of the reader the subject-matter herein contained is divided under three heads:

1. The natural condition of the region, as found by the early settlers, or, "what nature did."

2. The changes that have been wrought by the progress of settlement and through the agency of individuals and the national and State governments, or, "what man has done."

3. The question of the future development of forestry, with some few practical suggestions as to the duty of individuals, corporations, and the State and national governments, or, "what should be done."

Respectfully yours,

F. P. BAKER.

PRELIMINARY REPORT ON FORESTRY.

NATURAL CONDITIONS.

The vast country assigned to the writer for investigation is bounded on the east by the Mississippi, on the west by the winding chain of the Rocky Mountains, and extends from the British possessions to the warm waters of the Gulf. It embraces the States of Minnesota, Iowa, Missouri, Arkansas, Louisiana, Nebraska, Kansas, Texas, and a portion of Colorado, and portions of the Territories of Dakota, Montana, Idaho, New Mexico, Arizona, and the Indian Territory. Of this region the States of Missouri, Arkansas, and Louisiana are largely covered with native forests, and Arkansas in particular stands in need of facilities for bringing her magnificent lumber to market, and the day, it is hoped, is not far distant when the cypress of Arkansas will be as well known as the pine of Michigan and Wisconsin. Outside of these three States—Missouri, Arkansas, and Louisiana, which will be set aside for the present, to be spoken of hereafter—there yet remains an empire to which the subject of forestry is at present a vital one. The Mississippi throughout its length is lined by forests which increase in width as the number and size of its tributaries increase in volume. It is the presence of this great river which may be said to make forest States of the three we have mentioned.

In Minnesota the belt of forest is comparatively narrow; in Iowa somewhat wider, and it is in those States that the great prairie region begins which extends to the foot-hills of the Rocky Mountains. Going west from the Mississippi the Missouri is encountered, lined with forests for the last 200 miles in its course, above that running through a comparatively deforested region.

At the Missouri begins the ascent to the Rocky Mountains, the great field for the future exercise of all that man has learned or can acquire of the science of forestry. This region, as the elevation increases, becomes more bare, and, to the eye accustomed to mountains and forests, desolate. The forest keeps up a gallant struggle along the streams which flow eastward to the Mississippi and Missouri, the Platte, the Kaw, and the Arkansas, but finally diminishes to a thin, winding fringe of cottonwood or willows, and the eye for hundreds of miles sees no more till the pine-covered slopes of the Rocky Mountains appear dimly in the horizon. The traveler, coming within sight of the mountains and then turning southward, comes to New Mexico, with its mountains,

oft times bare to their very summits, and at other times covered with piñon and pines; its wide plains watered by inconstant, treeless streams and occasional ponds or lakes, traversed by but one stream of magnitude—the red, turbid Rio Grande, its banks destitute of trees or verdure save where the patient Mexican has dug his acequia or irrigating ditch. Then to the westward lies Arizona, a country of mountains, bearing everywhere the traces of volcanic action, extinct craters, lava beds, and the veritable sandy desert. As the border of Mexico is approached the barrenness increases. Nothing relieves it save where man has overcome it by irrigation. The Mexican does not rely on trees for his wood, but digs for fuel the heavy, branching roots of the mesquite. If the traveler, when within sight of Pike's Peak, turns northward instead of southward, and keeps his course parallel with the mountains, his way will lead him over the high plains, better watered and less desolate than those of New Mexico, but equally destitute of trees. Such is a general view of the country under discussion.

When the first settlement of this region began, the north half of Minnesota was covered with white pine, and south and west of the pine belt was a large body of hard wood, consisting of white, red, and burr oak and sugar maple. Of the total forest of the State (pine and hard wood mixed, and hard wood), it is safe to say that fully one-half has disappeared. Of the total area of hard wood, it is estimated that but 4,000,000 acres remain, the area of the State being, in round numbers, 54,000,000 acres.

The history of Iowa is that of the prairie States generally. The settlers found on the banks of the Mississippi, the Des Moines, its principal tributary, and other streams, a considerable amount of timber. This they proceeded to use up, after the manner of the American pioneer, particularly when he encounters timber on the government lands. Nature has since been repairing damages, but native timber has long since ceased to be a matter of reliance. In 1875 the forest area of Iowa was estimated at 2,300,000 acres, the area of the State being 35,000,000 acres.

Nebraska, as opened for settlement, was almost entirely destitute of timber. The supply was confined to the belt along the shifting banks of the Missouri, largely composed of willows and cottonwoods, with a hard growth in the bluffs and the ravines which intersect them. At the mouth of the Platte was a heavy body of cottonwood, and along the banks of that stream, where it was entered by tributaries, were groves of white and burr oak in area from 100 to 500 acres. Within the original limits of the Omaha land district, containing 2,560,000 acres, and comprising the most heavily timbered district of the State, the original plats showed but 75,000 acres of timber.

Kansas, although counted among the "treeless" States, was, in the beginning, blessed with more forest than Nebraska. Pike, who explored the country in 1806, speaks of the region now comprising the

east third of the State as a good country; but beyond the first 100 miles from the present border of the State of Missouri, he doubted if the country could be settled on account of the absence of wood. Within twenty years a fine body of forest extended along the Kansas River from its mouth to 135 miles west. In some localities, as at Topeka, 60 miles west of the mouth of the river, the body of timber, comprising fine specimens of every tree known to the latitude, was six miles wide. Colonel Fauntleroy, in urging in 1852 the establishment of the post since known as Fort Riley, at the point where the Republican and Smoky Hill unite to form the Kansas River, mentions the locality as desirable on account of the existence of one of the finest bodies of timber in the West. The banks of the Neosho, from Council Grove to the present line of the Indian Territory, were heavily timbered. Large bodies of cottonwood were found at Lake Sibley and other points on the Republican. The Marais des Cygnes, and in fact nearly all the streams of Eastern Kansas, were well timbered. Even in the extreme northwestern portion of the State, nearly to the borders of the plains of Colorado, fine groves existed on the small tributaries of the Republican, one of them being early named the Driftwood. After all the ravages of twenty years the amount of timber in the State is estimated at 2,560,000 acres, or 4.92 per cent. of the whole area.

Colorado had, at the time of the discovery of its mines, 25 years ago, a great body of pine, spruce, fir, and other trees covering its mountain sides. In 1870 it was estimated one-third, possibly one-half, of the trees in the settled portions of the Territory had been destroyed by fire and ceaseless slashing. Since that period railroads have penetrated the country, and have added to the destruction by consuming millions of ties. The original forest lands of Colorado are now being converted into deserts.

Wyoming is a country of high plains and lofty mountains. In 1873 it was estimated that there were 2,000,000 of acres of timber in Northwestern Wyoming. The business of cutting off the timber for railroad ties has been going on for many years. The consumption has been estimated at 500,000 ties per annum. Charcoal burning and the demand for mining purposes have also diminished the native timber. The elevation of the country renders it liable to frost every month in the year except July, which enhances the difficulties surrounding artificial forestry.

The mountains of Montana were originally covered with forests of pine, spruce, fir, cedar, and balsam. These forests have been ravaged by fire, and it has been noticed that where timber is once destroyed on these mountains it is not followed by a second growth.

Idaho presents great contrasts of surface and vegetation. The finest body of red cedar on the continent exists in this Territory, and, on the other hand, there are 16,000,000 acres of sage-brush lands, which are are, however, for the most part, susceptible of irrigation, and so offer a field for tree cultivation.

Dakota is a prairie country, and resembling in its general characteristics the adjoining portions of Nebraska and Minnesota.

It will be seen that the region west of the Mississippi and east of the Rocky Mountains comprises a great variety of soil and climate, and really the region should be divided into great districts, each to be made the subject of investigation and report. In such a division one district might be properly made of Minnesota and Iowa; another of Eastern Dakota, Nebraska, and Kansas; another of Wyoming, Western Dakota, Montana, Idaho, and Colorado; another of New Mexico and Arizona; and yet another of Missouri, Arkansas, Louisiana, Texas, and the Indian Territory. In some sections timber grows naturally in abundant supply; in others the need is planting and cultivation; in others in addition to planting and cultivation, irrigation seems a necessity. In other districts the question is that of preservation.

Every portion of our country is interesting in connection with the purposes and labors of the bureau of forestry, but the most interesting field of research and labor is that portion of the continent which is embraced within the limits of the States and Territories we have mentioned, and the boundaries of which were defined as follows by Mr. H. M. Thomson, of Lake Preston, Dak., in a paper read before the Forestry Congress at Montreal at the meeting in August, 1882:

> The Great Plains extend from the southern limit of the Staked Plains in Texas northwardly about 20 degrees of latitude to the Saskatchewan River and Hudson's Bay, and from an irregular east line, commencing in Texas, running through the eastern part of the Indian Territory, Eastern Kansas and Nebraska, Western Iowa, the big woods of Minnesota, and the Red River of the North; westwardly of this irregular eastern limit an average distance of about 10 degrees of longitude to the foot-hills of the Rocky Mountains, and containing an area of about 950,000 square miles. If all this region possessed a propitious climate, and all the soil were susceptible of cultivation, the area is sufficient to make 3,800,000 farms of 160 acres each, and which, by the aid of a proper forest economy, may be made capable of supporting an agricultural and pastoral population of fifty millions.

WHAT HAS BEEN DONE.

The first great step toward the promotion of forestry in this country was what may be called a change of sentiment in regard to the value of forest trees, a change which has taken place within the last half century. The pioneers on the continent made their settlements along a heavily-timbered coast, and for the better part of two centuries literally hewed their way toward the interior of the country until the great prairies were reached. Trees were not only cut down for use, but were slashed and burned and girdled. It seemed to be the purpose of the early American settler to destroy as far as possible the native forest. The woodman's ax was the symbol of civilization, and the State seal of Indiana bears the figure of a wood-chopper.

The setting out of orchards was, of course, the work of the earliest pioneers, a passion for fruit trees having been brought from England;

but the idea that a forest tree was of any value except to be used up for rails or posts or boards, or burned to ashes for pearlash, is of comparatively modern origin. Even when the settler reached the prairies of Illinois, where timber compared with the older States was very scarce, he does not appear to have exercised the least care or foresight. If he lived near the bodies of forest which skirted the streams, he cut them down for rails or cord wood, as if the supply was inexhaustible, and out in the prairie the settler contented himself with hauling green wood a long distance for firing, nor dreamed of setting out groves about his house which should supply his demand for fuel at less trouble and expense.

Kindly nature strove to repair damages, and in many instances successfully. And when, in time, men heeded the warning and became less lavish in the work of destruction, the woodland began to gain in area, until in many parts of Illinois it is now much greater than when the country was first settled. In time came the discovery of coal, which lessened the consumption of wood for fuel; and the question of material for fencing becoming serious, hedges and other substitutes for posts, plank, and rails were resorted to. Thus by degrees the subject of the value of forest, and so the possibilities of forest culture, became impressed upon the people; in short, forestry became a subject of popular interest.

An augmentation of this interest came with the settlement of the country west of the Mississippi, and more especially west of the Missouri. Here were immense treeless areas, and believed by the first explorers to be uninhabitable on account of the absence of forest for building, fencing, or even fuel; it was known that travelers and hunters traversing these plains used buffalo chips for fuel. And yet here were millions of acres of surpassing fertility, opened to settlement by the passage of the homestead act; and the progress of settlement stimulated by the extension of the railroads. It will be seen that under these conditions the forest question became one of the first importance. The rivers and the railroads solved the problem of building by bringing pine from the forests of the North, and the demand for fuel was met in part by the opening of mines of bituminous coal, which seem providentially to exist in most prairie countries. The fence question was met in Nebraska and Kansas by the general adoption, after much discussion, of the herd law, which does away with large farm inclosures. In the settlement of these trans-Missouri States every step tended to reveal the transcendent value of forests. The lack of them, though supplied as we have said, was felt, and as soon as horticultural and agricultural societies were formed, tree-planting became a subject of eager, active, and constant discussion, and so has continued to be ever since. It is safe to say that there has scarcely been a number of an agricultural or horticultural paper issued in the States of Minnesota, Iowa, Nebraska, or Kansas, in which the subject of tree-planting has not been discussed.

The first efforts to repair the deficiencies of nature were those made by individuals. All through the country embraced in the limits of this report is found a tree of quick and early growth, requiring little in the way of sustenance, living a long time on water alone, planting itself in the most unexpected places and sowed by the busy winds. This tree is the cottonwood, and being the first at hand it was everywhere seized upon by the settler and planted by thousands about the homestead shanty, along the boundaries of the prairie claim, and in the little public squares and along the streets of the villages which spring up in a week or a month. Although time and trial have proved that the cottonwood will not sustain itself on the high prairie unless carefully cared for, dying like the Indian with the growth of civilization, it will yet be held in remembrance in this western country as the first of trees, and its planting as the beginning of forestry. Many a settler in years to come will recount how the armful of little cottonwoods, which he pulled with his hands on the sandy bank of the river and carried to his claim, furnished in time the first shelter from the fierce winds and the burning sun.

In time the pioneer tree was followed by others, the black walnut, the maples, the box elder, the catalpa, and with wonderful success. The denizen of the town in Minnesota, Iowa, Kansas, and Nebraska proved quite as enthusiastic a tree-planter as the farmer in the country, and in Kansas the newer the town, as a rule, the more zeal has been displayed in the matter of tree-planting. Lawrence, the university city of Kansas, after twenty-five years is a town full of verdure; but the same is true of Wichita, a town which seven years ago stood treeless on the bare, sandy bank of the Arkansas.

As to the results of individual effort, without encouragement from the State or from societies, a small portion of the immense amount of evidence which might be furnished is herewith submitted.

The latest standard authority on tree culture in Kansas is the "Second report on Forestry, by the Kansas State Horticultural Society." In this pamphlet, in the shape of county reports, is briefly summarized the results of tree-planting in Kansas, together with the teachings of experience in regard to proper varieties, &c.

The counties reporting, through careful observers and practical tree-growers, are Allen, Atchison, Barbour, Barton, Butler, Chautauqua, Cherokee, Crawford, Cloud, Cowley, Davis, Dickinson, Edwards, Ellis, Elk, Harper, Harvey, Jackson, Jefferson, Jewell, Johnson, Kingman, Labette, Leavenworth, Lincoln, Lyon, Marshall, Miami, Mitchell, Macpherson, Montgomery, Morris, Pratt, Ness, Nemaha, Neosho, Ottawa, Pawnee, Pottawatomie, Reno, Rice, Rush, Russell, Saline, Sedgwick, Sumner, Wallace, Washington, and Woodson. A glance at the map of Kansas will show that these counties represent every variety of soil and climate within the limits of the State, and from the earliest settled counties, on the banks of the Missouri, to the newest, far out on the high

plains, and from the Nebraska line to the Indian Territory. The highest of high prairie and the low level bottoms of the Arkansas, but a few feet above the level of the river, alike send the same report, "Timber culture seems to be made profitable in this county."

Taking the older counties, Leavenworth reports:

Timber groves were planted in 1860, of cottonwood chiefly, and on upland, many of which are 50 feet high.

And taking the newer counties, Saline reports:

The age of the oldest successfully grown timber lot or grove in the county is not over ten years old; was planted on low lands, and composed of cottonwood. The average diameter of these trees is 12 inches and the height 50 feet.

The correspondent from Sumner County reports:

Timber-growing can be made a profitable investment. My first planting, now eight years old, affords me posts and poles for their uses on the farm and considerable fuel. I would not be without it for $50 an acre.

These extracts are from the report two years old; as to later evidence, Hon. Martin Allen, of Ellis County, an old resident of extreme western Kansas, writes:

I have myself been cutting and using timber for a number of years that has grown on the prairie since I came here, and many others within my knowledge are doing the same. Even the slow-growing black walnut has made annual additions of near an inch in the diameter of its trunk.

Hon. H. C. St. Clair writes from Belle Plain, Sumner County, Kansas:

In this county there are thousands of acres of cultivated timber. Every good farmer, one that has now come to stay, has from one to ten, and some twenty, acres in timber, consisting of cottonwood, walnut, ash, elm, box elder, maple, ailanthus, and catalpa. It is true that some varieties are of slow growth, and a beetle destroys the cottonwood on the high lands; but where timber lots are cultivated like an orchard, as they should be, timber-raising is a success, and money spent by the government to encourage timber culture on the plains is well spent.

Theodore Boggs writes from McPherson County, in Western Kansas:

There have been a great number of timber filings made in this county, and while some of them have been changed to homestead or pre-emption entries, there are a great many timber claims under a good state of cultivation, and the trees in most instances are healthy and doing well. I have trees on my farm near McPherson planted in the spring of 1873 that are as large at the butt as a man's thigh, and they are healthy and show no signs whatever of decay. The repeal of the timber-culture act would be a very bad thing for the plain regions, and I should be sorry to have it done. There are timber claims in this county that could not be had for $5,000, and inside of five years they cannot be had for $10,000. There is no question about the success of timber on these prairies if it is only planted and cared for.

So much may be gathered of the results of tree-planting in Kansas.

Nebraska in the matter of systematic forestry is far in advance of Kansas. Possessing a much smaller area of natural timber than Kansas, the efforts of the people to cultivate artificial forests have been more vigorous. The statement is made by J. T. Allen, forester of the Union Pacific Railroad, that Nebraska has now growing, and in the best possible condition, *forty-five million* of forest trees, and this planting extends 300 miles west of the Missouri River.

SUCCESS OF THE MENNONITES.

Under our homestead system, in fact under the general system by which the West has been settled, there have been exhibited few of the benefits of co-operation. Each settler is independent. He is supreme on his own quarter-section, giving and receiving little help from others. Were this different, did the settlers of a given district join with each other in developing the country, did they combine, for instance, in the great work of rendering the land beautiful and profitable with trees, much could be done. How much is shown by the example of the Mennonites in Kansas! These people, bound together by a community of race and religion, and the fact that they were all alike "pilgrims and strangers" in this country, emigrated from Russia in large bodies in 1876 and 1877, and settled for the most part in the counties of Harvey, McPherson, Marion, Butler, and Reno. They bought land in severalty, yet in contiguous tracts, and have, without being allied in any socialistic bond, aided each other in their labors. Settling in an open prairie country they have transformed it. Being intelligent tree-planters they have surrounded their dwellings with fruit and forest trees, so that at a little distance a Mennonite settlement looks like a grove. They early introduced the culture of the Russian mulberry, which, under their system of careful cutting, furnishes in three years from the start abundant fuel, beside fruit, and the leaves for feeding the silk-worms. The same care and skill everywhere displayed would transform the great plains and change the climate of the western half of the United States.

ARBOR DAY.

An instance of the value of united action, even though for a brief period, is seen in the institution of "Arbor Day." The credit of designating a certain day in the year when men, women, and children shall join in planting trees is due first to the State of Nebraska. It was later taken up by the State Forestry Association of Minnesota, and on the first Arbor Day in that State, in 1876, 1,500,000 trees were planted. Premiums were offered by the State Forestry Association and by individuals until every farmer in Minnesota seems to be a forester. In Iowa Arbor Day has become a fixed institution. In Kansas the day was first observed by the citizens of Topeka, who turned out under a proclamation from the mayor and filled the capitol grounds with trees, which remain to this day. The governors of Kansas have since issued their proclamations for the observance of Arbor Day, which has been observed, however, principally by the school children who have by their efforts greatly beautified many school grounds in the State.

ACTION OF RAILROAD COMPANIES.

We have spoken heretofore of the work of individuals. The work of forestry has been carried on to some extent by railroad companies, but

not to the extent desirable. The Atchison, Topeka and Santa Fé Railroad Company in Kansas some years ago employed a forester, but afterwards, probably believing that the experience of private parties had fully demonstrated the fact that trees *would* grow to the extreme western limits of Kansas, abandoned the experiment. The following statement is instructive in this connection: Under date of October 18, 1882, Mr. C. H. Longstreth, late forester of the Atchison, Topeka and Santa Fé Railroad Company, speaking of the efforts of that corporation to grow trees on the great plains, after it had been a question of great doubt whether trees could be grown there at all, states that, in connection with S. T. Kelsey, in 1873, he commenced tree-planting at Hutchinson, Kans., working from there westward. He says:

The object of our work was to settle this question and learn as far as possible what kinds of trees were best adapted to this part of the State for forest purposes. We did not do much until the spring of 1874, when we did considerable in the way of planting seeds and cuttings, most of which grew and promised well. In February, 1875, Mr. Kelsey left the work, after which I continued the planting and growing of trees until 1879, when, having the grounds all filled out and trees in such shape as to require but little care thereafter, the railroad company concluded best to discontinue the work and not plant any further.

Since 1879 the trees have had no work expended on them whatever. Below, I give notes of growth and number of trees now growing, which I took a few days since:

First point, Hutchinson, is 180 miles west of the east line of the State; elevation, 1,500 feet; soil, light, sandy loam. Here are now growing—

	No. of trees.
Cottonwood, 30 to 50 feet high	1,000
Box-elder (ash-leaved maple), 15 to 20 feet high	8,000
Black walnut, 12 to 18 feet high	2,500
Green ash, 15 to 20 feet high	3,600
Ailanthus, 18 to 24 feet high	1,200
Catalpa, 16 to 20 feet high	2,000
Elm, 15 to 18 feet high	200
Honey locust, 15 to 25 feet high	500
Gray willow, 30 to 40 feet high	500
Hackberry, 6 to 10 feet high	500
Soft maple, 12 to 20 feet high	1,000
Coffee bean, 4 to 6 feet high	3,000

Ellinwood, the next point, is 40 miles farther west; elevation, 1,750 feet; soil, a black, sandy loam, with a tenacious subsoil. Here are now growing—

Soft maple, 16 to 20 feet high	600
Honey locust, 15 to 20 feet high	400
Catalpa, 15 to 20 feet high	1,800
Box-elder (ash-leaved maple), 15 to 18 feet high	500
Ailanthus, 18 to 20 feet high	300
Osage orange, 12 to 15 feet high	2,000
Cottonwood, 30 to 40 feet high	2,000
Green ash, 12 to 15 feet high	1,500
Black walnut, 12 to 18 feet high	4,000
Gray willow, 25 to 30 feet high	600
Hackberry, 8 to 12 feet high	400
Elm, 15 to 18 feet high	500

Garfield, the next point, is 43 miles west of Ellinwood; elevation, 2,100 feet; soil, light loam. The following trees are growing here:

Cottonwood, 20 to 30 feet high	4,000
Box-elder, 12 to 15 feet high	2,700
Ailanthus, 15 to 18 feet high	5,000
Black walnut, 12 to 15 feet high	4,000
Soft maple, 12 to 15 feet high	800
Catalpa, 10 to 14 feet high	500
Honey locust, 15 to 20 feet high	400
Green ash, 8 to 12 feet high	2,000
Gray willow, 20 to 25 feet high	200

The above is a brief description of the results of our work down to the present time. All of these trees have been grown from seeds and cuttings. The conditions have been such as to put the trees to severe tests. There has been no extra work done with them. They have been simply planted and cultivated well. It has been stated that we irrigated a part of our ground. This is not the case. Our trees never received any water except what fell from the clouds. All of these trees at the present time show a promising and healthy appearance, with all prospects of making a rapid and mature growth in the future. This work has demonstrated beyond any question of doubt that trees will grow here with all success whenever planted intelligently and cultivated and taken care of as they should be.

It will be seen that the Atchison, Topeka and Santa Fé Company went no further than experiment to demonstrate that the growth of trees was possible in the region traversed by its line. The same was true of the Kansas Pacific, now the Kansas Division of the Union Pacific. Several experimental gardens or nurseries were started under the direction of the company, but abandoned years ago. Settlers in the same counties where these experimental groves were planted, have, on hundreds of timber claims, settled the point at issue.

The Burlington and Missouri River Railroad, in Nebraska, carried on some experiments for a short time, in the way of planting trees along cuts for snow fences.

The Missouri River, Fort Scott and Gulf Railroad Company has entered upon the work of forestry proper, that is, the raising of trees for actual use.

R. Douglas & Son, of Waukegan, Ill., have a contract with this railroad, which runs from Kansas City south, in Kansas, near the line of Missouri, to and beyond Fort Scott, Kans., to plant two sections of land in trees. One of these is located at Farlington, and the other at Hunnewell, near by. These places are about 125 miles south of Kansas City, Mo. Of the Farlington plantation Mr. Douglas, under date of October 24, 1882, writes:

Three hundred and twenty acres are planted, and we are now planting 180 acres more. That will be finished before winter sets in, or before April 1, 1883. The plantation consists of catalpa (*speciosa*), with the exception of a few acres. They are all planted 4 by 4 feet apart, containing 2,720 trees to the acre. The land is prepared same as for corn, and the trees are planted with spades. The catalpa trees planted in 1878, after four summers' growth, are 10 to 15 feet high and 2½ to 3½ inches in diameter. Three years planted, 5 to 9 feet; two years planted, 3½ to 6 feet (a drought last year); one year planted, 3 to 4 feet. On rich land these trees shade the

ground after two years' cultivation. On poorer land they require three years' cultivation.

On the Hunnewell plantation, 3 miles from Farlington, we have already planted 175 acres catalpa (*speciosa*) and ailanthus, and 60 acres of the white ash. The catalpa are one and two years planted; we will have 285 acres on the above plantation between now and April next, all catalpa and ailanthus, making 560 acres on the Hunnewell plantation. Our contract requires 2,000 trees to the acre when they are 4 to 6 feet high. Nearly every acre on both plantations will contain 2,500 trees; every acre will contain over 2,000 trees.

Beside the Missouri River, Fort Scott and Gulf, the only other railroad company reported as engaged in forestry is the Saint Louis, Iron Mountain and Southern. Mr. Kerrigan, superintendent, writes:

We have no trees planted on our road excepting 50,000 catalpa trees on right of way near Charleston, Mo. We have a plantation or farm of catalpa trees (100,000 trees) on Belmont branch, 18 miles from Belmont, Mo. The above were all raised from seed. We also have a catalpa farm of 250,000 trees at Bertrand, Mo., about 20 miles from Bird's Point, on the Cairo branch of this road. These were planted in June, 1880, from slips. Have been cultivated twice, and are now in fine, thrifty condition. Will average about 8 feet high, and will not require any cultivation after next year.

THE TIMBER-CULTURE ACT.

The general government, acting through Congress, has confined its encouragement of forestry mainly to the passage of the timber-culture act, which grew out of the homestead law, and is designed to be supplementary to it. The original Congressional timber-culture act became a law March 3, 1873. It was amended March 13, 1874, and was on the 14th of June, 1878, changed to the shape it now bears, and since the date of its last amendment most of the entries under the law have been made. That is, the law has been in practical, extensive, working operation but four years.

As showing the extent of operations under the act, the following table, furnished by Hon. N. C. McFarland, Commissioner of the General Land Office, is given:

tatement of the number and area of entries under the timber-culture laws in the different States and Territories, by fiscal years, from the beginning of operations to June 30, 1882.

States and Territories.	1873.		1874.	
	No. of entries.	Acres.	No. of entries.	Acres.
Arizona			2	196.51
California	2	329.75	59	8,878.06
Colorado			17	2,272.24
Dakota	24	3,560.00	865	124,997.29
Iowa	1	145.90	33	3,816.05
Kansas	60	9,642.17	1,954	282,479.07
Minnesota	95	14,710.15	804	113,131.63
Nebraska	137	21,858.07	2,164	312,712.09
Washington			22	2,482.22
Wyoming			1	80.00
Idaho			2	180.83
Total	319	50,246.04	5,923	851,225.99

Statement of the number and area of entries under the timber-culture laws, &c.—Continued.

States and Territories.	1875.		1876.	
	No. of entries.	Acres.	No. of entries.	Acres.
Arizona	2	320.00	10	1,197.15
Arkansas			3	231.92
California	195	29,065.53	136	20,524.33
Colorado	27	3,453.82	45	6,514.22
Dakota	451	61,969.75	842	119,835.23
Iowa	92	9,127.52	99	8,563.42
Kansas	1,265	168,269.06	1,354	185,596.43
Minnesota	499	63,673.73	1,070	140,126.30
Nebraska	1,061	130,894.26	834	106,499.74
New Mexico			7	1,128.00
Oregon	7	882.68	13	1,793.18
Utah			3	399.88
Washington	31	3,324.14	54	5,374.28
Wyoming	1	180.47	1	160.00
Idaho	21	2,583.25	17	1,973.89
Total	3,652	473,694.21	4,488	559,917.97

States and Territories.	1877.		1878.	
	No. of entries.	Acres.	No. of entries.	Acres.
Arizona	21	2,440.00	11	1,600.00
California	75	10,586.05	60	8,029.42
Colorado	28	3,343.33	125	17,436.73
Dakota	476	68,266.92	3,769	579,804.04
Iowa	59	4,791.56	89	7,535.47
Kansas	1,666	238,020.44	4,031	593,295.17
Minnesota	561	76,021.53	2,693	377,017.78
Montana	3	398.59	9	960.00
Nebraska	706	90,812.90	1,408	195,306.68
Nevada	2	240.00	5	600.00
New Mexico			2	320.00
Oregon	19	2,509.37	130	18,446.31
Utah	3	338.50	9	1,280.00
Washington	148	19,746.75	562	78,237.00
Idaho	52	7,035.91	158	22,169.53
Total	3,819	524,551.85	13,061	1,902,038.03

States and Territories.	1879.		1880.	
	No. of entries.	Acres.	No. of entries.	Acres.
Arizona	21	3,280.00	6	719.65
California	112	14,458.81	99	12,120.31
Colorado	121	16,142.03	214	30,302.14
Dakota	4,675	728,687.83	5,575	868,748.39
Iowa	73	6,577.67	57	4,714.05
Kansas	7,776	1,167,582.77	2,891	408,261.74
Louisiana	1	80.43	1	40.00
Minnesota	1,847	257,642.50	909	123,735.36
Montana	27	3,134.20	61	6,835.32
Nebraska	3,183	465,968.94	3,202	475,275.87
Nevada	1	160.00	5	560.00
New Mexico	14	1,891.93	24	2,887.95
Oregon	130	18,446.21	482	73,061.66
Utah	9	1,280.00	35	4,044.05
Washington	562	78,237.00	893	134,637.65
Wyoming			9	240.00
Idaho	162	22,013.93	181	23,300.04
Total	18,629	2,775,502.66	14,644	2,169,484.18

Statement of the number and areas of entries under the timber-culture laws, &c.—Continued.

States and Territories.	1881.		1882.	
	No. of entries.	Acres.	No. of entries.	Acres.
Arizona	6	760.00	9	1,352.77
California	201	24,538.28	306	39,882.99
Colorado	195	26,473.31	329	47,436.05
Dakota	5,133	868,400.36	9,368	1,466,532.34
Iowa	55	3,644.25	82	6,235.62
Kansas	1,924	268,575.09	1,933	273,053.55
Louisiana	19	2,293.40	7	1 004.02
Minnesota	1,168	167,582.16	1,220	176,741.42
Montana	131	16,535.20	266	35,409.94
Nebraska	1,682	240,306.94	2,086	298,520.11
Nevada	7	1,040.00	10	1,520.00
New Mexico	16	2,039.26	24	3,351.99
Oregon	212	31,176.40	590	88,038.77
Utah	35	3,921.52	32	3,831.71
Washington	540	77,008.62	603	87,524.76
Wisconsin	1	40.00		
Wyoming	5	784.30	20	2,284.44
Idaho	224	28,680.26	272	33,965.61
Total	11,554	1,763,799.35	17,157	2,566,686.09

By this table it will be seen that, since the passage of the original act in 1873, 93,246 filings, covering 13,637,146 acres, have been made. Of that amount there have been entered since the passage of the amended law in 1878, 11,177,510 acres.

Of this amount of 13,637,146 acres on which timber filings were originally made, it is safe to say, from information received from various government land offices in the prairie States and Territories, that at least one-third has, for various causes, been cancelled or entered under other acts, leaving, say, 9,000,000 acres held for the present under the provisions of the timber-culture act.

Before giving an opinion as to the practical operations of the law, attention is called to the statements of those who, from official position or other circumstances, may be supposed to have the best opportunities for practical observation of the workings of the act and the amendments it needs to make it more efficient, Hon. Charles A. Morris, register of the United States land office at Larned, Kans., writes:

I have to state, in reply to your letter, that there have been made at this office, since it opened for public business, February 15, 1875, 4,611 timber-culture entries, embracing about 700,000 acres, and of these entries there have been canceled by contest and voluntary relinquishment about one-third, embracing about 233,000 acres.

The object of the timber-culture law is to encourage and foster the growth of timber on the western prairies, and the fact that it is not more generally successful is owing to the traffic in "claims," entered under its provisions by claimants who appropriate public lands under this law for speculative purposes, and when opportunity offers, sell to homestead and pre-emption settlers; thereby not only defeating the object of the law, but forcing the new comer to pay a bonus to secure a desirable location for a home which he otherwise might have obtained at a minimum cost, to-wit, the government fees. This evil can be remedied and the law made effective, and the growth of forest trees on the western prairies assured, by so amending the timber-culture act of June 14, 1878, as to provide that land once entered under its provisions be ever afterwards appropriated thereunder, and not subject to entry under any other

law. I would suggest that section 3 of the timber-culture act, approved June 14, 1878, be amended as follows, viz:

"*And be it further provided.* That lands once appropriated under this act shall not, in case of the cancellation of a timber-culture entry or from any cause, be subject to entry under any other law, but shall be only subject to entry under this act."

An amendment of this kind would stop speculation of the nature I have stated, and, in my judgment, insure, beyond question, the successful growing of timber in Kansas, for land once entered under this law would be thereafter forever dedicated to the successful growing of timber, and title could only be obtained, be he original claimant or otherwise, by making the growing of timber a success, and it has already been demonstrated that timber can be successfully grown even in western Kansas, by honest and intelligent effort.

E. A. Knidler, register, and C. H. Gould, receiver of the United States land office, at Miles City, Mont., present some valuable ideas about the operations of the timber-culture act in the following letter:

We would state that the intention of the act is excellent. Theoretically the law is good, but in the practical application of the same it has proved very faulty.

It is an excellent law for speculators in prospective town sites, as one person at least in eastern Montana has discovered, said person taking up a "tree claim" at the cost of $14, and, before expending one penny for breaking, even, received $5,000 for his relinquishment.

We are of the opinion that out here nine persons out of ten, who make timber-culture entries, do not expect to ever plant a cutting, slip, or to sow a seed of a tree.

The lands most sought after in this land district are the bottom lands along the Yellowstone, the Tongue, Powder, and Rosebud rivers, and nearly every section along and skirting those streams contains more or less timber. The average speculator endeavors to take the best bottom lands and with just as many trees upon the section, and frequently upon the tract actually entered under the timber-culture laws, as they dare or can; they hold the land a year or two, and then, if it is not contested as fraudulent, they relinquish their entry, asking that their right and fee and commissions be returned to them, upon the ground that the entry cannot be confirmed, the land not being subject to timber-culture entry. There has not been to our knowledge a cutting, seed, or a tree planted upon a timber-culture claim in this land district, but cottonwood trees have been planted in the yards and streets in town, and nearly all have grown, although the ground has never been prepared or cultivated. In our opinion, trees can be successfully raised upon prairie land by careful and intelligent care and culture.

We think the present timber-culture laws should be repealed or amended as follows, viz:

1st. The applicant should be required to swear that he personally examined the whole section of 640 acres, finding the corners of the same, and that there is not at the date of the affidavit, and apparently never has been, upon the said 640 acres any trees, shrubs or brush growing thereon, excepting ——— (describing the growth). This would enable the local officers to judge by the affidavit as to the character of the land. Under no circumstances should the applicant be allowed his right and fee and commissions restored to him.

2d. When a tract of land has once been withdrawn by a timber-culture entry it should not thereafter be subject to homestead, pre-emption, scrip location or cash entry, provided the land should be properly subject to timber-culture entry. Nor should more than three timber-culture entries be allowed for the same tract, the former entry having been cancelled for relinquishment, or upon proof of non-compliance with law after contest. The tract thereafter (the three timber entries have been made) to become the property of the State, upon proof of compliance with the requirements of the timber-culture laws on the part of the duly authorized agent for the State.

This, we think, would stop speculators from taking timber-culture claims, and would have the effect of eventually establishing ten acres of good timber upon every even numbered section of United States lands, the same being prairie land.

3d. The amendment of the act, whereby the same commissions and fees are to be paid by the applicant as would be required under the homestead laws for the same tract.

Under the homestead laws the applicant for 160 acres of double minimum land in Montana, and ten other States or Territories, is required to pay at date of entry $10 fee to the United States and commissions to the local officers of $12, and the same commissions for the local officers at the time of proving up under the homestead law, viz., $12. Under the timber-culture laws the fee to the government is the same, but the commissions to the local officers are only $4 to be paid when entry is made, and $4 to be paid when proof is made; making a loss to the local officers of $18 for each 160 acres taken under the timber-culture laws.

Thus the law as it now exists virtually offers a premium, and makes it a great object to local officers where the maximum is not attained (and those are in the majority) to discourage timber-culture entries. We do not think the timber-culture law strong enough to carry so heavy a weight; they are too heavily handicapped.

We may be too strong in our suggestions to suit you, but the above are our honest opinions.

Loren Listoe, register of the United States land office at Fergus Mills, Minn., says:

The timber-culture act by no means has proved to be of so great a benefit to the public as had been expected, still I would consider it a great calamity and a serious mistake if said act should be repealed. It is true that a great number of acres have been entered by speculators under said act, who, for instance, hold it two or three years and then sell their rights to other parties. But on the bleak prairies of this State and Dakota I know of a great many claims which have been entered by parties, actual settlers, who honestly try to carry out the provisions of the act.

Hon. J. V. Bogert, receiver of the United States land office at Bozeman, Mont., speaking of relinquishments under the timber-culture act, says:

It is my opinion that speculation, expense and labor mainly caused the relinquishments. I do not conclude that the relinquishments, to any extent at least, are caused by the failure of trees to grow, if properly cared for.

It is my opinion that the time given in which to perfect an entry is too long; it encourages speculation in public lands, enabling parties to hold them eight years, in very many cases without planting a tree. Contests are not so often brought; parties do not like to antagonize neighbors; while the fact that inclosed or cultivated land has been taken under the timber-culture law may be, can be, and no doubt often is concealed.

I see no reason why parties should not be obliged to plant a certain area in trees, and during the first continuous summer succeeding their filing, if made *during* a summer, and during the summer succeeding filing if made *prior* to a summer. I do not notice any necessity for the first year's plowing and the second year's cultivation, if I am to judge from local success with trees without said work and use of time. Of course, I know that trees require care and ground preparation, but, were said two years not given, more compliance with the law would follow and less speculation in entries result. Again, at stated times during pendency of each case, parties should be obliged to appear at the local land office and prove compliance with the law. This would force compliance or relinquishment, and do away with eight years' withdrawal of much land.

W. E. Powell, the general agent of the Chicago, Milwaukee and Saint Paul Railroad, writing of the workings of the timber-culture act, and referring particularly to the Territory of Dakota, says:

The tree-claim law is shamefully abused in that Territory. While it was made for the benefit of the actual settler, there is no chance for him to get a tree claim at all. They are all taken up in each township by speculators in less than twenty-four hours after the township is in market. They file them under fictitious names and hold them until a settler comes and buys them for $300 or $400 each, but, if they cannot sell them before improvements must be made on them, they relinquish them to each other or to some unknown parties, and get new filings on them, and they can keep them so many years without any planting whatsoever, thus circulating reports among the ignorant that trees will never grow on prairie land. We will prove to the contrary.

D. S. Hall, register of the land office at Benson, Minn., says:

I have no doubt that the timber-culture law is, and has been, a cloak for covering large tracts of good land by parties who have no idea of ever complying with the law, as far as planting trees is concerned; but a slight amendment to the law, requiring the parties to promptly and strictly comply with the requirements thereof, would remedy the evil and stop the fraud.

D. S. Grimes, a gentleman of great experience in tree-growing, and for many years a resident of Denver, Colo., writes:

With the timber-culture act as it now stands, the incentive to planting is to secure title. The claimant does as little as possible to comply with the requirements of the law; he has no pride or sympathy with his work only as refers to obtaining title. The planting, protection, and healthy-growing of his trees for eight years is sworn to by interested and accommodating neighbors, hence this act is often taken advantage of. To repeal this act would do the West great injustice. It should be amended so as to compel a faithful performance of the contract on the part of the claimant. Instead of one entry of 160 acres to each section there should be two entries allowed, not to exceed eighty acres each upon a section of 640 acres to be planted to timber in the same proportion as provided for in 160-acre tracts. The advantage of dividing 160 acres into individual timber entries can plainly be seen:

1st. The timber is in two plantations instead of one, and perhaps located in opposite parts of the section, and will be benefiting twice the number of settlers.

2d. One hundred and sixty acres are too much for a man of limited means to cultivate successfully; the area of land being so much greater than his ability to control, neglect and failure will result.

A State or district forester of practical experience should be appointed by government, whose duty should be to give information free to all applicants upon the subject of forest-culture. In making final proof on a timber entry the forester should first make a personal inspection of the lands claimed under the act, and if the law has been fully and faithfully carried out, then his certificate should be sufficient evidence that the law has been complied with. This will not only compel the party claiming land under the timber-culture act to be thorough in planting and cultivating, but will save to the government thousands of acres annually that would otherwise pass into the hands of dishonest claimants.

Mr. D. Pratt, an old resident of the plains country, sends the following suggestions:

I would first repeal the acts granting lands for timber culture and for pre-emption claims, and permit claims to be taken only under a modified homestead act. The changes I would suggest in the homestead act are as follows: I would allow a settler to take any number of claims he chooses, up to one section, 640 acres, with this proviso, that on each and every quarter section granted him he should plant, culti-

vate, protect, and maintain 16 acres of timber across either the entire north or south side of said quarter section. The planting I would require to be done in the following manner, viz: Previous to the first day of June next succeeding said homestead entry, he should break across the entire north or south side of each quarter section not less than four acres. And previous to the first day of each succeeding June, for three consecutive years thereafter, 4 acres more, or until 16 acres are broken. The first 4 acres should be planted within two years, or the second spring after the land is broken, and 4 acres more planted annually thereafter until the 16 acres are all planted. The land should be thoroughly cultivated the year previous to planting, and each succeeding year, till the trees are at least six years old. I would make the cultivation of the land thus granted, other than the 16 acres above specified, entirely optional with the grantee, but would require an actual residence on the land, which the timber-culture act does not.

S. M. Emery, of Lake City, Minn., says:

My personal observation in tree-planting has, in the main, been confined to the portion of the West contained in Western Minnesota, Northern Iowa, and Eastern Dakota, where many farms have been taken under the timber-culture act. These apparently have not always been successful in the production of timber, not from any constitutional difficulty in the soil but from force of circumstances, and these mostly arise from the inability of the pioneer settler to obtain suitable stock for planting, the lack of knowledge as to culture, and lack of means to give the land suitable cultivation. I have seen some very fine groves of artificial timber, mainly white willow and cottonwood. There is nothing in the working of the law that prevents the growth of timber. Land well broken and backset the first season, cropped to flax the second season, this cut, and the land plowed and harrowed thoroughly in the fall, immediately after harvest and then planted to either box elder seed or hardy seedlings; and then the same care given the crop that a good crop of corn should receive, will surely produce a magnificent growth of trees. This I know for a personal fact, having had the management of five timber claims aside from my own. The number of claimants who have proved up is small beyond doubt, as it is not a law of long standing. That there are frauds under the law we do not doubt, but it is fashionable now-a-days to do this. If millions of acres of valuable pine timber can be stolen under the pre-emption act, it would not be strange if fraudulent proofs may be made on timber claims. I have thought much over the best way for government to manage the timber claim filings. It does not seem right for a man to cover 160 acres for three years, then relinquish to some other party who can do the same thing, and thus indefinitely cover and hold a piece of land. Again, the law is much abused in the planting of seed. It would seem advisable to me that a claimant in case of contest for non-compliance with the law, who should base his defense on having planted seed which did not germinate, should be made to show by at least four witnesses of unimpeachable veracity, that the seeds were actually planted and that a series of as formidable questions and answers as are needed for proof paper should be used to prove his defense. This would work no injury to innocent parties, and would certainly have the effect of making men careful. I think the law should plainly state that 27,000 trees should be planted on 10 acres in rows eight feet apart, trees two feet apart in the rows. This will admit of crop cultivation in half the soil and will leave trees in better shape for trimming. I think an annual cultivation should be required, for at least six years of the eight. It might be worthy of consideration, the idea of allowing a man to commute at the end of the fourth year from filing, provided he can prove the existence of 625 good trees on each of 10 acres by payment of $1.25 per acre. The effect of all this would be to open up that much more land. Of course no purchaser would destroy so valuable a property as 10 acres of growing timber. * * * I am sanguine that we will yet see our bleak prairies dotted with noble clumps of timber, the result of the act.

It will be seen that the testimony of these witnesses, government officials and others, is uniform. They all state that in many instances the law fails of its main object, the extension of the forest area of the country. The great evil pointed out by of all them is everywhere the same, viz., the sale or transfer of timber claims by the original claimants to speculators and other parties.

We have already called attention to the fact that of the 13,000,000 acres filed under the timber-culture law, at least one-third has been canceled or entered under other acts. It is safe to say, with the statements herein given before us, that within a brief period, unless the law is amended, a large portion of the 9,000,000 acres remaining will be diverted in a similar manner. Admitting that the law is defective and that men are dishonest, and that they perjure themselves in regard to timber-culture claims just as they frequently do in regard to the homestead filings, is it proven that the law utterly fails of its intention; that it has accomplished no good purpose, or that it cannot be made to do so? The testimony does not show this. None of the land officers or others whose observations we have given recommend the absolute repeal of the act; they simply recommend its amendment and its enforcement. The objection made that natural causes make compliance with the law impossible, in other words that trees cannot be made to grow with proper care, is nowhere sustained. On the other hand, the evidence is overwhelming that in all the country between the Mississippi and the Rocky Mountains trees will grow under cultivation, and that no man can yet say where the line is located beyond which forestry is unprofitable.

From a mass of letters and reports from all part of this vast region we give the following:

B. P. Hanon, of Reno County, Kansas, writes:

In every instance in our knowledge where suitable varieties have been planted and properly cared for afterwards, they have grown well and proved satisfactory.

Mr. E. E. Ballou, of the United States land office at Helena, Mont., says:

I am fully satisfied that cottonwood, balm of Gilead, and box-elder, all of which are native, can and will be cultivated successfully here. The silver-leaf poplar also grows quite as thrifty as any of them. I should much regret the repeal of the timber-culture act, for I think it will prove a great blessing to this as well as other Territories if continued.

Mr. D. S. Hall, register of the United States land office at Benson, Minn., says:

No person who knows anything of western prairies will deny that planting trees thereon is the very thing of all others to make it a place to be inhabited by man. I speak from years of personal experience when I say that it is perfectly natural and easy for trees to grow on these western prairies. Where prairie fires are kept from running, groves of trees spring up at once. I know of a grove of heavy timber, containing 60 acres, which stood in the center of the prairie, miles from any other timber, in Renville County, this State. This grove was almost surrounded by water,

which protected the land from the ravages of fire. It was called Bird Island. I could refer you to any number of illustrations to show you that trees will grow on these prairies if you will only let them, and also that by the slightest effort nearly all of the valuable timber-producing trees may be successfully grown out on the prairies.

The evidence of E. T. Byram, county surveyor of Jewell County, Kansas, is to this effect:

If any one has any doubt about this matter he has only to pass through this and adjoining counties and see the beautiful small groves and windbreaks of different varieties of forest trees to be fully convinced that trees will grow on the prairies 200 miles west of the Missouri River. There has no doubt been a great deal of deception and fraud practiced in regard to timber entries; but the same may be said in regard to homesteading. I do not know how these evils can be remedied, but I do know that, although I have less than three years remaining of my threescore and ten, yet if I needed to do so I would plant forest trees with an abiding trust that I would live to reap the benefit of my labor, and that in less than ten years I would have all the fuel I would need year in and year out.

Loren Listoe, of the United States land office at Fergus Mills, Minn., gives his opinion as follows:

In this land district but three timber claims have so far been proved up; upon all of these the trees were in good condition, and one of them which I have myself inspected presents to-day as fine an appearance as if it was a regular nursery, composed of cottonwood, ash, and white willow; the trees are from 12 to 20 feet high, and some of them fit to be used for fence-poles to-day. I think it can be safely said that any man who will prepare his ground properly, and cultivate the trees after they are planted, can raise timber successfully in this State, and in Dakota, where I am acquainted.

T. G. Clark writes from Osage County, Kansas, a hundred miles west of the Missouri River:

Tree-planting on the prairies is no longer an experiment, but a successful business. The time has come in the history of this nation to encourage the planting of forest trees, and I think it unwise to repeal the timber act. I think the law should not restrict the planting of every valuable variety of trees, but let the settler plant such kinds as will succeed best.

FORESTRY AND IRRIGATION.

It is asserted that a vast portion of the interior country of the continent, including portions of the States of Texas, Kansas, Colorado, and the Territories of Dakota, Wyoming, and New Mexico cannot be cultivated without irrigation, and this brings up the very natural question, why should they not be cultivated with it? It is admitted that forests affect the rainfall, or at any rate the general humidity of the atmosphere; why should not the rule be made to work both ways, and forests be sustained by the water now available, even in the most arid portions of the country, and the forests, on the other hand, be made to preserve and increase the supply of moisture?

The great open, high, and dry country of which we are writing, estimated in extent at three hundred miles wide and eight hundred miles long, is not naturally unfertile. It is not a sandy desert, or a rocky waste, of no intrinsic value for agricultural purposes, but the soil for

the most part is a rich loam, possessing the constituent parts of rich tillable soil.

The country is not entirely destitute of water, by any means; it is traversed by the Canadian, the Arkansas, the upper waters of the Kansas, the North and South Platte, the Rio Grande, the Nebraska, the Cheyenne, and many such streams as the Cache la Poudre. These streams are alike in their character; each has a wide shallow bed, shifting channels, swift currents, and a fall of from seven to ten feet to the mile. The banks are very low and the valleys wide, and with a descent to the eastward corresponding to the fall of the streams.

With water, and a fertile soil which only needs water, why should not the two be brought together? This is, briefly, what may be termed the "irrigation question."

To consider the difficulties, first, it is said that the streams mentioned cannot be depended on to furnish the requisite amount of water at the season when it is needed. To this objection it is answered that there is every natural facility for the construction of immense reservoirs for the storage of water during the winter and the portion of the year when there is a surplus; and, further, that the great plateau is traversed by subterranean streams which may be reached by digging. The surface streams, which seem to dry up at some seasons, merely sink into the sand, and the fact is called to mind that in 1859–'60, the driest season ever known within the memory of man, when in the country west of the Missouri no rain fell during a period of nearly twelve months, water was found by digging in the beds of these streams.

The best and safest rule in endeavoring to ascertain whether a thing can be done is to secure an answer to the question, "Has it been done?" Applying this rule to the irrigation question it will be found that irrigation has been successfully carried on along the banks of the Rio Grande for the three hundred years that the country has been known to white men, and for indefinite centuries before the Spaniards landed in North America. The irrigating ditches in the valley of the Pecos may have been dug when the pyramids were young.

The results of irrigation carried on by an imperfectly civilized and unprogressive people, with the rudest implements, may be seen from the point where the Rio Grande leaves the mountains, for hundreds of miles; and amid a land which elsewhere seems cursed with eternal sterility, winds the green belt of trees and orchards, of fields and vineyards watered by the Rio Grande or its tributaries, from the garden of the archbishop of Santa Fé to the mass of verdure which enfolds the old New Mexican town of Las Cruces.

This is the work of a people with no scientific knowledge of hydraulic engineering, carried on with hoes and plows such as were in use in the days of Abraham. Can no more be done by Americans than by New Mexicans and Indians? Are the resources of modern agriculture inferior to the unchanged inventions of a Pueblo Indian? Must we aban-

don a country to desolation which Mexican peons have found capable of cultivation?

Answers in the negative are not wanting. Not to speak of the wonderful success achieved by the Mormons at Salt Lake, the scene of which is outside of the region which is properly to be discussed in this report, there may be cited what was once known as the "Greeley experiment," which is an experiment no longer. Saying nothing of the success in the direction of farming and gardening which has made the Greeley community one of the most prosperous in the United States, the growth of trees has been enormous. The cottonwoods planted in the early days of the colony are giants in size now, and other trees are growing finely and will eventually take the place of the "pioneer tree." Not far from Greeley is Fort Collins, the seat of the agricultural college of Colorado, and of the success of tree culture there, P. M. Hinman, the secretary of the college, writes:

In regard to the growing of trees in this region, I will say that there has been a large growing interest taken in the past few years, and trees are being put out very extensively; I know of some walnuts in bearing and others being planted. Should think that the next ten years will find a very rapid increase both in amount of land devoted to the growth and the kinds planted.

This is but one case. At various points in Colorado and in Wyoming irrigating ditches, to be in some cases 60 miles in length, are in course of construction. Wherever these ditches run, trees will grow transforming the face of the country. It has been noticed, too, that in abandoned ditches young cottonwoods spring up by thousands, the presence of water the year before seeming in some manner to promote their growth.

At Garden City, Kans., near the borders of Colorado, on the line of the Atchison, Topeka and Santa Fé Railroad, irrigation has been begun on a scale which bids fair within a few years to be the most extensive within the limits of the United States. The source of supply here is the Arkansas River, and the fall is so great that the water taken from the river twenty miles above Garden City, when it reaches that point, can be carried over the high plateau known as the "Second Bottom," and so an immense area is embraced within the possible limits of irrigation.

With the first beginnings of cultivation trees were planted, and their growth has been surprising. This much has been demonstrated, that there is nothing in the character of the soil to prevent a tree growth as luxuriant as can be found anywhere within the limits of the United States.

The theory that the high plains were once covered with forest, and that at a not remote period, is sustained by some remarkable facts. It is certain that the trunks of large trees are found in the bluffs or hills, miles from the water courses, and that not many years ago these giants of a century's growth were quite numerous.

Long before the settlements had encroached upon these plains, the Arkansas, the Platte, and other streams were skirted with timber which

gradually disappeared as you traveled westward. These same streams were supplied with considerable bodies of timber from the mountains eastward. The intervening distance from where the timber disappeared on the east to where it again begun on the west was perhaps two hundred miles, although in the adjoining bluffs, at points where no trees or even brush was found along the streams, bodies of old trees were found and used extensively for firewood.

The digging of irrigating canals is the signal for a heavy volunteer growth of timber along their borders, the cottonwood, the willow, and the elm predominating. Forest trees planted by the settlers or ranchmen upon the bottom lands at any point between the Missouri River and the mountains seem to live and flourish without further attention. All plainsmen remember the immense "lone cottonwood" tree that stood for a century, far removed from the Arkansas River in the vicinity of Fort Dodge, Kansas. For years large supplies of cedar were found in the hills near Julesburg, Nebr., not far from the confluence of the North and South Platte Rivers; this timber was used extensively by Ben Holliday's overland stage line even as late as 1865.

The average annual rain-fall of this great plain, which extends from the Territory of Dakota to the Rio Grande, does not exceed 12 inches. Although it is claimed that timber will not grow in a region where the annual rain-fall is less than 20 inches, and although it may be argued that the great plains are treeless because they are rainless, and not rainless because they are treeless, people who have lived on the eastern border of the great desert for the last quarter of a century and noted the climatic changes wrought in that time, and who have seen this border pushed westward several hundred miles, have faith to believe that not only will the civilization of the Missouri Valley, fostered and sustained by modern forms of agriculture, be met from the west by that sustained by artificial water supply, but that the nineteenth century will witness the highest forms of horticulture and agriculture successfully practiced upon an unlimited scale in the very heart of this now treeless and rainless desert.

KNOWLEDGE IS POWER.

The great gain so far made is that of knowledge, and to this great gain every discussion, every report, every experiment, every success, every failure even, has contributed. The too enthusiastic have learned moderation, and the despondent have been encouraged. No man who has looked over the ground will maintain that all kinds of trees will grow in the high prairies and plains that grow in lands of mists, rain, and mountain, and, on the other side, no thoroughly posted and practical prairie farmer or plains-man will say that trees will *not* grow even in the constantly diminishing precincts of the "American desert."

SUITABLE VARIETIES.

It has been decided what trees grow best in the prairie States, and a hundred tree planters selected from different localities in the States and Territories embraced in this report would, if called upon, report the same varieties. They are the ash, black walnut, box elder, cottonwood, honey locust, Osage orange, silver maple, catalpa, Russian mulberry, white elm, and gray willow. It is not to be understood that no other forest trees will grow; many other trees are indigenous; but it is to be understood that where a selection is to be made these trees are most available. In selecting others the chances of losing time and money are increased.

PROPER METHODS OF CULTIVATION.

In addition to this useful knowledge certain points have been reasonably well settled in regard to the cultivation of these trees, and we give these directions in the language of one of the most successful foresters in the country, Mr. C. H. Longstreth:

Trees should be planted closely, for immediate and mutual protection; second, for economy in culture; third, for the purpose of securing valuable timber and early returns from the planting. There evidently was a want of practical knowledge with our law-makers on this question when they framed and passed the timber act allowing trees to be planted 12 feet apart each way. Trees planted such wide distances can never serve the purpose of a forest, but will virtually become an open orchard.

Propagation.—As a general rule the best and cheapest mode of growing trees for timber is by means of the seed; some kinds, such as the cottonwood, the willows, and most of the poplars, may be readily propagated from cuttings.

Preparing the ground.—In preparing the soil for planting of seeds and young trees it is essentially necessary that the ground should be deeply plowed and well pulverized.

Distance apart.—We have practiced planting in rows 4, 6, 8, and 12 feet apart, with trees 2 to 3 feet apart in the row, the results so far being in favor of rows 4 feet apart. Trees that naturally grow upright may be farther apart than those of a spreading habit. In no case would we recommend putting the rows over 6 feet apart.

Planting.—Seeds that start with a delicate growth should be planted in nursery rows, or in a seed bed, to be transplanted to the forest at one or two years old; seeds and cuttings of a vigorous growth may be planted right out in the forest rows. The nut-bearing trees do not transplant well, and the seed should be planted where the trees are to remain. We would advise, most decidedly, not to allow your trees in nursery rows to get more than two years old before transplanting; and they are better transplanted at one year old. One-year old trees are sure to grow, having, in proportion to the top, more and better small fibrous roots. Young trees cost less throughout in handling and planting, and in the end make a larger, thriftier, healthier, and better tree every way. Be careful not to expose the roots of trees in handling; set them one or two inches deeper than they stood before, and press the earth firmly about the roots.

Cultivation.—To be successful in the growing of trees it is essentially necessary that they should receive good, thorough cultivation. You might just as well expect to grow a crop of corn without cultivation as a crop of trees. Too many people allow their trees to die or be ruined for want of a little care and cultivation, and then complain that tree-growing is a failure. Neglect is a failure everywhere. Cultivate well in the early part of the season; allow no weeds or grass to grow; stop all cultivation with the plow after the middle or last of July, this being done in order to let the trees

have time to ripen their wood and be in good condition for the winter; pull or hoe out all the weeds that may come in late in the season. In plowing among trees a short whiffletree should be used to avoid injuring the trees. All trees planted in the spring should be ridged the following November by turning a furrow against them on each side with a light plow; the ridges may easily be leveled in the spring with the cultivator. After three or four years, or as soon as the trees shade the ground, they will need no more cultivation, and will thereafter need but little care. Be careful to keep stock from running among the trees, as they are very injurious, even after the trees attain a large size.

Pruning.—This is a subject that has been much discussed, and in regard to which there are various opinions, some even contending that trees should not be pruned at all. I shall consider it here only in relation to forest culture. When there are more than two leading shoots they should be cut out to one, leaving the largest. Any side branches which detract in size and vigor from the leading shoot should be shortened or cut off entirely. This is all the pruning we find necessary in a closely planted forest; nature will do all other pruning.

Thinning.—Here is where we get our early returns. Several of our rapidly growing trees, if they have been properly planted and taken care of, may, in four or five years, be thinned out to advantage, care being taken to leave the straightest and most vigorous trees; then thinning gradually as the trees grow larger.

In a convention of nurserymen and tree-growers it is quite probable that there would be found gentlemen to take exception to these rules. It is also true that these directions were given originally for the benefit of Kansas tree-growers; yet Mr. Longstreth's views as to varieties, close planting, and cultivation have been indorsed by tree-growers and men of experience all over the country, west of the Missouri, writing without consultation with each other.

THE BEST TREE.

Something has been learned, too, of the relative value of trees. Limited as the list seems, few persons will care to plant them all, and a choice must be made. In making the selection we should advise as the first choice the black walnut. It seems for the first three or four years a slow grower, but after that period it grows rapidly; and admitting that the soft-bodied trees grow faster at the start, they are of little value when grown, while the black walnut has an actual money value greater than that of any other American forest tree. It should be the Western forester's main reliance; but between the walnuts experience has shown that other trees should be planted which put forth their leaves earlier, though they may not be worth so much for their wood, such as soft maples, box elders, or cottonwood. The latter have the farther advantage of compelling the black walnut tree to run up straight and high, and they serve to shelter and protect it from the hot sun and drying winds.

INFLUENCE OF DISCUSSION.

The varieties best for planting and their mode of cultivation having been definitely settled, the next great step is to ascertain and employ the best means to foster and encourage the work of tree-planting. In this direction much has been done. Societies, notably the Forestry

Association of Minnesota, have done much, and meetings like those of the American Forestry Congress at Cincinnati and Montreal have excited general interest. It is certain that never before in the history of this country has forestry been so generally a subject of interest among all classes of people.

THE FUTURE OUTLOOK.

It is but nine years since the timber-culture act, the first law of Congress designed to encourage tree-growing, was passed. It is only four years since the law was so amended as to encourage action under it. The first timber claims are now being proved up, and the advantages and demerits of the law are now fully known. The subject has already been discussed in these pages. There can be no doubt that Congress will take action and so amend the law as to prevent fraud, and embody in the law the condition, "once a timber claim, always a timber claim," and so give an immense impetus to tree-growing on the prairies. Thus, with increased and increasing knowledge; with enlightened self-interest, and the government of the nation pledged to the protection of the forest lands, still the common property of the people, from spoliation, the encourager of the honest settler under the timber-culture act, and in time, the active promoter of schools of forestry, we have much to hope for.

WHAT SHOULD BE DONE.

In a country like this, where the power of the general government is scarcely known or felt, reliance must be placed upon the voluntary action of the individual. In European countries, where the government regulates everything, even to the amusements of the people, a system of forest laws can be adopted making the planting and preservation of forests obligatory, but such a system cannot be inaugurated here. The government cannot here compel all men to set out trees or care for them; and it is questionable if it can give much successful encouragement in the way of bounties. On the other hand, the Government of the United States has a right to take care of its own. A quarter-section of land in the prairie or on the mountain side is, until it is conveyed by the government to a corporation or individual, as much the property of the United States as is the Capitol at Washington, or a fort or vessel flying the flag of the United States. It is as much the duty of the general government to protect that quarter-section from invasion or spoliation as it is its duty to save the Patent Office or Treasury buildings at Washington from robbers or incendiaries. Of course, the letter of the law recognizes this principle, but no laws have been more systematically violated than those designed for the protection of government lands. The theory has obtained that these lands belong to the first settlers, and that their product is to be used by them for their own individual benefit, under the plea of "Developing the resources of the country." Every man who has cut cord-wood on the government land and sold it and put the money in his pocket has justified his course by saying that

the operation "developed" the country and thus increased the value of the government land itself. Nothing can be more pernicious in theory or practice than this. These lands do not belong to the first settler or the first thousand settlers who may come into their vicinity; nor the first corporation which may gain a foothold. They belong to the nation, which is the trustee for fifty millions of people. A citizen in Maine has as much interest in them as a citizen in Kansas or Colorado.

SPOLIATION OF GOVERNMENT TIMBER.

In regard to the forest lands still the property of the United States, the question has arisen, shall they be protected for the benefit of the country and of generations yet to come, or shall they be reduced to desert wastes for the private benefit of speculators and corporations? Take the case of the government forest lands in Colorado. Twenty-four years ago the slopes of the Rocky Mountains were covered with the untouched forests sufficient, if properly cared for, to supply the *reasonable needs* of the settler and miner, as contemplated by the law, till the end of time. In the shadow of these forests rose the headwaters of the Rio Grande, Platte, and the Arkansas, and the snow in the deep woods melting slowly, the rise of the streams was gradual and uniform for a long period. To-day these mountains are being left peeled and bare. The mountain side is being converted into a bald, bleak desert, the springs are drying up, and the Rio Grande, Platte, and Arkansas now rise with sudden violence and then sink as suddenly in their dry and diminished beds. In other words, the people of Colorado, Kansas, and New Mexico are having inflicted upon them incalculable injury, and a wrong is being done which, if not arrested, will affect disastrously generations yet unborn.

In return for this devastation of its property the government receives nothing; its magnificent estate is laid waste, and it gains nothing in the way of recompense. The land is nominally in market at $2.50 an acre in bodies of 160 acres to one individual, but it is not being purchased to any extent. With a view of aiding the poor settler or needy miner, a law was passed some years ago allowing him to take timber for domestic use, meaning thereby, evidently, his personal use, for fencing, firewood, or lumber necessary in the actual construction of his mining shaft. The law was certainly liberal enough, and was so liberally interpreted by the settlers that it was found necessary to send government agents to the spot to protect the rights of the government; but since that period the words "domestic use" have been interpreted to mean the right of the "party of the first part" to cut timber and sell to other parties for their use. Under this ruling there were lying in one mountain stream in September, 1882, half a million railroad ties, indicating by their length that they were intended for the "domestic use" of a broad-gauge railroad outside of the limits of Colorado, where the narrow-gauge is the usual standard. This is but one instance. Movable

saw-mills traverse the country, using up every tree valuable for sawed lumber; these are followed by the railroad-tie cutters, who take every tree large enough for one tie; to complete the work, charcoal-burners follow, using every stick that is left. We have before us a pamphlet setting forth the advantages of a Colorado town, and therein is the statement that within a radius of ten miles sixty charcoal-kilns are running, with a capacity of 4,000 bushels each per month, and representing a monthly distribution of $30,000. This charcoal is being made from wood belonging to the United States, which receives therefor no compensation of any sort; and, moreover, the actual settler in the vicinity is being deprived of the wood granted him for his own use, and is being forced to go miles for wood enough to cook his food; and last, and worst of all, drought and desolation are being invited in order that a few individuals may reap a temporary profit out of the government.

HOW THE FOREST MAY BE PROTECTED.

The few illustrations offered may serve to give an idea of the situation along the whole eastern slope of the Rocky Mountains, so far as occupied by miners or penetrated by railroads and railroad-tie cutters. It is safe to say that no other government on earth, liberal or despotic, would suffer itself to be thus despoiled; and in this country the offense is greater because it is not the robbery of some prince, potentate, or individual, or class of individuals, but of the whole people. The evil is glaring and evident, and the remedy should be prompt and certain. It is suggested that the most effectual is the *withdrawal of all government timbered land from market*, and the sale of the timber under government regulation in such a manner as to protect the forest from extinction. To illustrate, the forest lands might be divided into districts of reasonable extent, each under care of a government inspector, whose duty it shall be to supervise the forest growth, to bring trespassers to justice, and to see that only such trees are sold as can be spared without detriment, or whose removal would be advantageous, or that no trees below a certain size shall be cut on tracts designated. It should also be made his duty to exercise oversight of tracts from which the merchantable timber has already been removed, to see that the young growth is not injured, and especially that it be protected from fire. In the beginning, for what is done should be done at once, this duty should be performed by capable and discreet men, without any personal or property interest in the districts committed to their charge; men acquainted with the value of timber and its habits of growth, and, above all, men of incorruptible character.

GOVERNMENT FORESTERS.

To the end that this duty, which is to be perpetual—for it should be understood that the government forests are never to be destroyed—there should be a body of young, energetic, and practical men educated by

the government, and standing in the same relation to it that the graduates of West Point and Annapolis do, competent, faithful, and fond of their work of preserving to the government and people of the United States a domain greater in value than all its mines of silver and gold. To raise up this class, there should be established such a number of national schools of forestry as may be found necessary, care being taken that the schools are distributed in the different sections of the Union according to climatic division and the character of their natural forests, as, for instance, the white-pine regions, the southern pine and cypress country, the regions where the walnut, maple, elm, and deciduous trees are the prevalent growth, and the high prairies and treeless plains and mountain slopes where, most of all, the forester is to find work.

SCHOOLS OF FORESTRY AND EXPERIMENTAL FARMS.

Attached to each of these schools there should be an experimental farm, where every tree known to the United States should be planted, and in certain localities, as determined by their natural dryness and altitude, the methods of irrigation as applied to forest culture should be thoroughly tested.

With these two questions of reforesting the plains—we use the word reforesting because it seems evident that forests once grew on the plains—and also of the possibilities and value of irrigation to be determined, the suggestion has been made to the writer that the general government should in some manner establish a series of experiments, or rather a continuous test, to scientifically settle the matter. Given a treeless region, eight hundred miles long and three hundred wide, to be reforested, largely by means of irrigation, there should be, in the opinion of thousands of intelligent people, some point selected where on an extensive scale trees may be planted, the different systems of irrigation applied, and results noted, and this through a series of years. This would settle, perhaps, that in some districts, generally embraced in the arid region trees may be grown *without* irrigation. This is the opinion of Mr. D. S. Grimes, of Denver, a gentleman of vast experience. Mr. Grimes believes that trees planted in "dead furrows" and mulched will in four years shade the ground sufficiently for their own protection. This theory might with others be tested to the great benefit of all concerned. In the Western country individual scientific interest combined with munificence cannot be relied upon to establish and maintain such an institution as a school of forestry and experimental farms. The land-grant railroad companies may in time plant forests to test the capability of their lands or to raise trees for their own use, but they have no interest in educating foresters. The States, with their agricultural colleges, have no sufficient facilities. It seems, then, that the general government should enter upon the work. The Government of the United States, acting for the people, has the greatest interest. In years past it has expended millions in the exploration of this vast domain.

It has expended millions in warring with the hostile savages who have roamed over it. It has a second mortgage on the great railroads which traverse it. The Government of the United States, being the greatest land holder, also has a paramount interest in reclaiming this empire and converting it from a wilderness to fields, gardens, orchards, forests, and pastures. That the government should actually do the work is not to be expected, but it seems to be reasonable to expect that it should aid in doing it. Knowledge is power; and let the government furnish the knowledge. The government owns the land; it can set apart any amount of it which may be required; it can place the work in the hands of the best practical talent of the country; it can do on a large scale what individuals are doing on a small scale. As the government is impersonal and can be accused of no sinister or selfish interest, the statements put forth under the sanction of the government officers and agents will be received as the truth. It will be shown what trees can and what cannot be grown on the plains; what are the effects of copious and limited irrigation; what is the actual amount of water required for given areas; what is the result of irrigation on the same land for a series of years; and, most important of all, what is the effect of planting large bodies of trees—actual forests.

AMENDMENT OF THE TIMBER-CULTURE ACT.

So far the only legislation by Congress intended directly for the encouragement of practical forestry is what is known as the timber-culture act. It has been several times amended, and needs further amendment. It has been so long in existence that its faults are well known, and there should be no hesitation in remedying the law, that its original purpose should be carried out as far as the intention of any law is attainable.

The law contemplated that when a quarter section was taken as a timber claim, it should be held as such until the terms of the law had been fully complied with, and a certain number of trees had been added to the forest area of the country. The intention of the act, according to the testimony of government officers and other competent witnesses, has been avoided; non-residents and speculators have taken claims under the timber-culture act merely for the purpose of selling them to persons who wished to take them as homesteads or pre-emptions. It will be readily seen that this is an absolute avoidance. It works a failure of the object of the act. The remedy for this seems to be the adoption of the principle, "*Once a timber claim, always a timber claim.*" By this is meant that when a filing has been made under the timber-culture act, the land should be withdrawn from entry under either the homestead or pre-emption acts, so that the title shall never be perfected except in compliance with the letter and spirit of the timber-culture act.

The law is defective in allowing trees to be planted as far apart as

twelve feet. Young trees need each other's support. Close planting is the law of nature, and nurserymen are more and more coming to recognize it, west of the Missouri at least. Taking the ground that the object of the law is to have the ground covered with live trees and not dead ones, the greatest distance allowed between trees at planting should be four feet. If the trees when growing become too thick they will be trimmed out by nature herself.

TIMBER ON HOMESTEADS.

The power of the government over public lands is absolute. It can, in conveying them, impose any regulation not in hostility to the "general plan of granting the public domain to actual settlers under reasonable conditions." In addition to the actual occupancy for five years now required, the homesteader might with profit to himself and advantage to the country be required to plant and maintain during the five years one acre in forest trees, or set a row of trees along the highway, or both.

WHAT STATES MAY DO.

Except in Texas, where the State owns all the public land, the States own nothing but the school lands and lands granted for educational purposes. The power of the States over them is absolute, and in their sale the condition might be imposed on the purchaser that a certain portion of the land shall be kept in forest. The legislatures of the several States may take action making it obligatory on school directors to maintain trees on school-house grounds, and also making it compulsory on land owners to keep trees growing along the country roads.

DUTY OF RAILROAD COMPANIES.

The duty and the interest of the great land-grant railroad corporations lie in the direction of the encouragement of forestry. Next to the general government, these companies are the greatest land owners on this continent. They have received from the government and municipalities, from the people, in short, an imperial gift, the source of immeasurable wealth, and this has been given them almost without conditions. It is but just that they should in return do everything possible toward the improvement of the country their lines traverse; and it is also their interest to do so, since whatever increases the productiveness of the country increases their own business. These corporations, with their great and hourly increasing wealth, can do what individuals cannot do, and on them devolves the inauguration of the plan of planting great forests—not little experimental gardens, not a few trees in the depot grounds, but tracts such as are found in Europe of tens of thousands of acres. It is estimated that every year 275,000 acres are stripped in this country to furnish railroad ties, and the process of restoration must keep pace with that of destruction, else the time will come

when railroad ties cannot be secured at any figure. Why should not a great railroad company, with millions of acres at its disposal, raise its own railroad ties? We have spoken elsewhere of the very praiseworthy experiments of the railroad companies in the direction of tree-planting. But the experience of tens of thousands of practical men, farmers and others, has shown that as far as Minnesota, Iowa, Kansas, and Nebraska are concerned, the era of experiment has passed. It is, for instance, as well known now as it ever will be, that the catalpa, the black walnut, the osage orange will thrive, and that they may be profitably cultivated. Instead, therefore, of continuing the discussion of a settled question, the railroad corporations should set out trees; not by the hundreds of acres, but by the thousands. This is a case where timidity, conservatism, and niggardliness mean loss. There are many ways, too, in which railroad corporations may foster the forest interests, as the distribution of forest-tree seedlings, nuts, and seeds. A private firm, R. Douglas & Son, of Waukegan, have sent out millions of trees in packages by mail. A great railroad company could do this on an even greater scale with the prospect of a sure return. In a few years they would not be obliged to seek remote and almost inaccessible mountains for ties, but would have them growing within sight of their own tracks for hundreds of miles. We do not doubt that the facts here set down will be recognized as the truth sometime, but every day of delay is a day of loss. But after the national government has done what it may, after State governments have done what lies in their power, the question of reforesting and of supplying with forest the region now destitute depends upon the people, and their action depends on an affirmative answer to the question, "Does it pay?"

LET US PLANT FOR OURSELVES.

We have, in a previous chapter, demonstrated that the planting of forest trees *does* pay; but the evidence which can be given within the limits of a report like this is but a drop in the ocean of procurable testimony. From the sandy plains of Cape Cod, swept by the bitter winds of ocean, where pine plantations have successfully been cultivated, to the sage-brush plains of Colorado, the answer is the same, that trees as a crop are profitable, paying as surely as corn or the other cereals. Those who have not made the subject a study have no conception of the amount of printed matter that has been and still is constantly accumulating on this subject; the observations of individuals, the reports of committees, the transactions of societies, cover hundreds of thousands of pages, and in them all there is not the evidence of a single human being to the effect that he had lost time or money in planting trees. Much sentimental talk has been indulged in concerning our duty to the next generation. We should plant trees, it is said, under which our grandchildren may repose. This is doubtless a fine and ennobling sentiment, but the average American citizen cares little

for the generation preceding him, and nothing for the generation to come; he expects the next generation to provide its own shade. The question he wishes to determine is whether the trees he plants will benefit men in this generation. Curiously, people almost always overestimate the age of trees. Who has not heard a great elm or oak spoken of as centuries old when it really has grown within the lifetime of living men? Trees are a sure crop, and, after all, a quick crop. The homesteader who goes out on the raw prairie knows that it is five years before his farm can be producing crops with anything like regularity. His trees are making a return as soon as his fields are. The Mennonite settlers in Kansas, of whose success we have spoken, in seven years, at the farthest, from the time they turned the first sod, are literally sitting in the shade of the trees they planted; are raising their own firewood, and eating the fruit of their own mulberry trees. What these settlers from Russia, strangers to our climate and soil, can do, others can do. It must be remembered, too, that the objectors have had their day: every argument which can be used against the cultivation of forest trees has been used in the prairie States west of the Mississippi against the cultivation of fruit trees. For example, men accustomed to hillside orchards in the old States have demonstrated to their own satisfaction that apples would not grow in Kansas; but wagons full of round and rosy evidences to the contrary may be seen standing in the streets of every Kansas market town. The number of those who till the soil, be it a bit of garden ground or acres by the hundred, who believe in the profitableness of trees, is constantly increasing. In front of the humblest cottage in town you see the three or four maples or elms covering the front of the lot; and out on the wide prairies, as far as settlement has extended, the group of planted trees marks the outpost of the picket guard of civilization. It is with the hope of contributing in some way to this useful and beautiful pursuit, which is to shelter the bare and blistered earth; which is to catch and hold the rain and the dew; which is to shelter the home and its occupants from summer's heat and winter's cold; which is to bring fuel and comfort to the housewife; and which is to increase by millions the well-earned wealth of a nation, that this brief report is submitted to reading and thinking people.

Respectfully submitted.

F. P. BAKER.

TREE PLANTING AND GROWING ON THE PLAINS.

Hon. GEO. B. LORING,
Commissioner of Agriculture:

SIR: This paper is intended only as a brief presentation of experiences and results concerning tree culture and tree growing onthe western plains, made by and coming under immediate observation of the writer during a residence of twenty-seven years west of the Missouri River, in the Territory and State of Nebraska, the principal object being to show what has been done practically, is being and may be done, converting a naturally timberless portion of country into a tree-growing region. Taking the geography of boyhood days, together with official reports of Captain Miles, United States Army, and the western explorer, Colonel Fremont, relating to that portion of the national domain situate between the Missouri River and Rocky Mountains, as a basis for conclusions, there was at date of extinguishment of Indian title to these lands in 1854 nothing enticing to enterprising adventurers seeking new homes in the far West, especially in matters of tree-growing. The thought that the then naked plains would ever be transformed into groves of valuable timber was not entertained. Those who first came, during the years 1854–'55–'56, soon discovered, however, that, particularly along the borders of streams and where prairie fires were kept out, there was promising spontaneous indigenous growth of valuable varieties of timber —oaks, black walnut, hickories, elms, ashes, red mulberry, honey locust, hackberry, linden, soft maple, sycamore, Kentucky coffee tree, red cedar, cottonwoods, willows, and others. Still later it was found by experiment that native seedlings transplanted into carefully prepared soil did well on high uplands—out on the open prairie not only did well, but grew with remarkable vigor and rapidity, showing characteristics of excellence in quality. To those of indigenous growth were added in time varieties of foreign origin—hard or sugar maple, American chestnut, white walnut, poplar, beech, birch, black locust, larch, pines, catalpa, black cherry, and others. While success followed efforts in this direction, only the most sanguine adventurous experimenters had faith in ultimate practical results. In time, through an act of the Territorial legislature, creating a board of agriculture, the labors of the board organized under its provisions, and afterwards liberal legislative appropriations, keeping out annual fires, and other aids and precautions, tree-growing in Nebraska is universally conceded a success. There is now no hesitancy or risk in predicting in the near future that it will be known and characterized as a timber-producing region of country.

EXTENT OF TREE PLANTING AND GROWING.

But little tree-planting was done in Nebraska, and by reason of annual fires sweeping very generally over the country spontaneous growth was exceedingly meager, for at least ten years after organization of the Territory, and first efforts by settlers to improve and develop. To cover all the ground and afford a more satisfactory presentation of the subject-matter under consideration, commencement is made with date of passage of Kansas-Nebraska act, 1854. From that time up to and including the year 1882, covering a period of twenty-eight years, official statistics, with some reliable estimates to cover dates not thus provided, it is found there has been planted within the borders of what is now the State of Nebraska 244,356 acres of forest trees. This includes seedlings, seeds, and cuttings planted in permanent forests, groves, and along highways and streets in cities and villages. Spontaneous indigenous growth, since fires have been kept from borders of streams and ravines, is estimated equal to half the area planted.

Personal observation would warrant a larger proportion. Not a few informants contend for an equal extent; some higher, even to double. James T. Allan, Omaha, ex-secretary American Forestry Association, now in employ of the Union Pacific Railroad Company, traveling extensively over the State, responding to inquiries on this particular point, writes: "I have watched the spontaneous growth of young elms, walnuts, oaks, ash, hickories, &c., along the Missouri, Wood, and other rivers in the West, since fires have been kept back, and seen their growth among the hazel brush, which is the fringe on the border of native timber, dividing it from the prairie. I hardly think I am out of the way in setting it at double the amount of timber planted."

A majority, however, in various parts of the State, place the estimate as stated—at one-half.

It is safe to say a majority of planting is made, originally, four feet by four, with view to cutting out first one-half, as growth demands space, and eventually another half of that remaining—three-fourths in all. Some plant six by six, others eight by eight. Planted four by four we have 2,622 trees to the acre, or a total of 640,701,432; eight by eight, 682 to the acre, or a total of 166,680,792. Average the totals, and there is shown 403,676,112. Add to the average the spontaneous estimate, one-half, and the grand total is, planted and grown in 28 years, 605,514,168 trees.

The number of trees per acre, spontaneous growth, will more than equal one-half the acreage planted. It is estimated one-fourth of the trees, seeds, and cuttings planted did not grow, and therefore not now occupying the ground. Spontaneous growth, except where the weak have been crowded out by the strong, and such as may have been destroyed by occasional fires, it may be said all are growing.

DEMONSTRATED USEFUL AND VALUABLE VARIETIES.

It has been practically demonstrated that the following valuable varieties of forest timber can be successfully and satisfactorily grown—both planted and of spontaneous growth. Only the most valuable are named in this list. Those designated with a * are indigenous.

Ash:

*Fraximus Americana.**
*viridis.**
*quadrangulata.**
*pubescens.**
*platycarpa.**
*sambucifolia.**

Oak:

*Quercus alba.**
*obtusiloba.**
*macrocarpa.**
*prinus.**
*tinctoria.**
*rubra.**
*nigra.**

Chinquapin oak—*prinoides*—of shrub character, grows in abundance, particularly on the bluff lands adjacent to the Missouri River, and in places in profusion on prairie lands, many acres in a body. It is a profuse bearer; nuts equal almost to chestnuts. In early days it was considered a "Munchausen" story when old settlers talked of hogs eating acorns from trees. The small growth, often not over a foot high, was loaded with nuts, and therefore easily eaten off by swine. Deer and antelope fatted on them.

Black walnut:

*Juglans nigra.**

White walnut:

Juglans cinerea.

Hickory:

*Carya alba.**
*sulcuta.**
*tomentosa.**
*porcina.**
*amara.**

Elm:

*Ulmus Americana.**
*fulva.**
*racemosa.**
*alata.**

Hackberry:

*Celtis occidentalis.**

Honey locust:
*Gleditschia triacanthus.**
*monosperma.**
Kentucky coffee tree:
*Gymnocladus canadensis.**
Linden:
*Tilia Americana.**
Sycamore:
*Acer pseudo-platanus.**
Black locust:
Robinia pseudacacia.
Soft maple:
*Acer dasycarpum.**
Sugar maple:
Acer saccharinum.

Sugar maple grown thus far little else than for ornamental purposes—lawns and street trees. There is no reason why it may not be grown successfully for forest purposes, as it thrives well when introduced and planted.

Poplar:
Liriodendron tulipifera.
Wild black cherry:
Prunus serotina.
Wild red cherry:
*Prunus Pennsylvanica.**
Catalpa, hardy:
Catalpa speciosa.
Cottonwood:
*Populus monilifera.**
*heterophylla.**
Willow:
*Salix purpurea.**
*cordata.**
*longifolia.**
*nigra.**

Valuable characteristics are noted of a willow growing spontaneous along the Missouri River from the mouth of the Big Nemaha, south, to the Yellowstone, north, familiarly known as "Diamond willow." Professor Sargent names it *Salix cordata*, var. *vestita.* Experience demonstrates it as durable for underground uses—posts—as red cedar.

Box-elder:
*Negundo aceroides.**
Chestnut
Castanea Americana.

Pine:

Pinus sylvestris.

Austriaca.

strobus.

Red cedar:

Juniperus Virginiana.

Larc

Larix Europœa.

Americana.

Mulberry:

*Morus rubra.**

alba.

moretti.

Many varieties of less value than the foregoing, embraced in a complete sylva of the State, are here omitted as not of practical value for forest purposes.

GROWTH OF TREES.

The following actual measurement of tree growths, of known ages, are made, showing circumference in inches two feet above ground:

Names of trees.	Years old.	Inches.
White elm (*p*)	15	24¾
Red elm (*s*)	24	36
Catalpa (*p*)	20	48½
Soft maple (*s*)	18	54¾
Soft maple (*p*)	18	69¾
Sycamore (*p*)	16	43¼
Pig hickory (*s*)	24	37⅜
Shagbark hickory (*s*)	24	30
Cottonwood (*s*)	23	78¼
Cottonwood (*p*)	22	93
Chestnut (*p*)	14	24½
Box elder (*s*)	14	25¼
Box elder (*p*)	14	31⅜
Honey locust (*s*)	22	40¼
Honey locust (*p*)	22	41½
Kentucky coffee tree (*s*)	14	25¾
Burr oak (*s*)	22	30⅜
White oak (*s*)	22	29
Red oak (*s*)	22	37½
Black oak (*s*)	22	38¾
White ash (*s*)	22	32¼
Green ash (*s*)	22	30
Black walnut (*s*)	22	48
Black walnut (*p*)	22	50¼
White walnut (*p*)	22	49¾
Osage orange (*p*)	25	26¼
Larch (*p*)	10	24
White pine (*p*)	20	36¼
Scotch pine (*p*)	15	23
Austrian pine (*p*)	15	22½
Red cedar (*p*)	15	26½
White cedar (*p*)	15	22
Mulberry (*p*)	18	43
Mulberry (*s*)	18	39½
Linden (*s*)	14	35
Poplar (*p*)	4	12
Black locust (*p*)	24	60½
Red willow (*p*)	20	58
Gray willow (*p*)	15	26½

s, spontaneous growth. *p*, planted growth.

ORDER OF VALUE.

The order of ultimate value, deciduous varieties, while there may be difference of individual opinion, it is safe to arrange: white, burr, and chestnut oaks; black and white walnut; white, green, and blue ash; black cherry, catalpa, black locust, honey locust, Kentucky coffee tree, elms, hickories, larch, soft maple, hackberry, mulberry, cottonwoods, willows, box elder.

For present or near value, cottonwoods—especially the yellow—are almost universally conceded preferable. There are, as shown, two varieties, yellow and white—*monilifera* and *heterophylla*. The yellow makes excellent lumber, particularly for inside uses, not exposed to weather. For shingles, only pine, cedar, or walnut are superior. Both make good fuel, after reasonable drying or seasoning. Old steamboat and mill men prefer half-seasoned cottonwood to any other obtainable in this region, claiming they get more steam from it; also much used in burning brick. No other wood holds nails so well.

Red cedar, white, Scotch, and Austrian pines stand in order of value as evergreens, and are usually so planted.

ORDER OF PLANTING.

The order of tree-planting, numerically speaking, of deciduous varieties is, as near as may be, cottonwoods, box elder, soft maple, elms, ashes, black walnut, honey locust, catalpa, oaks, hickories, Kentucky coffee tree, black locust, larch, sycamore, hackberry, mulberry, black cherry, and willows. Two-thirds of the whole are cottonwoods, from the facts they are more easily obtained, cost less, are of more rapid and certain growth, and from which realizations are more speedily and certainly secured, and, in addition, succeed almost anywhere planted.

SPONTANEOUS GROWTHS RANGE IN ORDER OF VALUE.

Oaks: red and black, perhaps, predominating; hickories: more shagbark than others. Black walnut, elms, linden, white ash, mulberry, and hackberry on higher lands; on bottoms, cottonwoods, box elder, willows, sycamore, soft maples, green and water ash.

PRICE OF FOREST-TREE SEEDLINGS.

Prices of forest-tree seedlings are such as to place them within reach of the very poorest; in fact, as the great bulk planted are of spontaneous origin, they are to be had for mere gathering in regions where found. When trafficked in, prices range, owing to variety and size, from six inches to four feet, all along from fifty cents to three dollars per thousand; nursery-grown plants grade higher. Many millions are now planted annually.

ENCOURAGING ENACTMENTS AND PROVISIONS.

The Nebraska State constitution provides that "the increased value of lands by reason of live fences, fruit and forest trees grown and cultivated thereon shall not be taken into consideration in the assessment thereof." A State law "exempts from taxation for five years $100 valuation for each acre of fruit trees planted, and $50 for each acre of forest trees;" also makes it obligatory that "the corporate authorities of cities and villages in the State shall cause shade trees to be planted along the streets thereof."

Further: "Any person who shall injure or destroy the shade tree or trees of another, or permit his or her animals to do the same, shall be liable to a fine of not less than $5 nor more than $50 for each tree injured or destroyed."

To encourage growing live fences the law permits planting "precisely on the line of the road or highway, and for its protection to occupy, for a term of seven years, six feet of the road or highway"

ARBOR DAY.

This day originated in Nebraska through action of the State Board of Agriculture. It is a day designated by the board during planting season, each spring, usually about the middle of April. The board annually award liberal premiums for the greatest number of trees, cuttings, and seeds permanently planted on that day. The governor annually, by proclamation, recognizes the day for purposes indicated, urging the people to devote it exclusively to tree-planting. It is very generally observed, and millions of trees planted that day.

MODES OF PLANTING AND TREATMENT.

The usual distances apart are by multiples 4, 8, 12, 16, &c., that intermediate ground may be utilized by being cultivated in other crops until trees are of sufficient size to protect themselves, when, in farm parlance, they are permitted to "take the ground."

Most experimenters at first planted tree seeds where they were to remain permanently. Experience has shown this a mistake, for numerous reasons. Principally, by this mode, uneven stand, growth, grade, size, and vigor are to contend with. By planting seeds first in beds, and, say at one year's growth, assorting, grading, and transplanting permanently each grade to itself, better results are secured. The same grades as to size and vigor do better together; grow more evenly; the weak are not crowded out or overshadowed by the stronger—a practical illustration of the "survival of the fittest."

By this plan small plants, if healthy, do about as well in the end as the large. No variety is known that cannot be safely transplanted at one year old. Even varieties of tap-root characteristics—oaks, walnuts, hickories, and chestnuts—are really better, I am convinced, for tap-root

pruning. By it laterals, or fibrous, feeding roots are induced; or, if larger sizes are desired before transplanting, root pruning, by running a tree-digger under rows and allowing them to remain a year or two longer, good results are obtained. As a rule, however, better success is had by transplanting young trees when, as near as possible, all roots are preserved. Small trees cost less to purchase, transport, handle, and transplant. Alternating, especially certain varieties, has not given satisfaction. Trees in some respects are not unlike mankind—will not fraternize. For instance, oaks, walnuts, and hickories will not fraternize with maple, cottonwoods, and elms. When planted near each other, the latter will invariably lean away from the former, assuming crooked, gnarly appearance, and in the end virtually die out.

INCIDENTAL ILLS.

Thus far few ills have attended timber culture in this State. The great losses or failures have been from careless handling, planting, and after neglect. Black locust was planted extensively in earlier days, but, being so badly affected by borers, its cultivation, until of late, was almost entirely abandoned. The pest which almost universally destroyed it in the beginning, suddenly and without known cause disappeared, and that valuable variety of timber is again receiving merited attention. In certain portions of the State, during one or two years, a large green worm, name not known, defoliated most soft maples, for a time checking their growth. In a few instances the same borer attacking black locust, to a limited extent injured soft maple and cottonwoods. They being of such rampant growth, injury was not material. Trees attacked were principally those used for ornamental purposes—those on streets in cities and villages.

Where ground has been well and deeply prepared, good healthy plants used, care exercised in handling and planting, followed by attention and proper cultivation until able to care for themselves, there has been no good cause for complaint.

IMPORTANCE OF SPONTANEOUS GROWTH.

Too much importance cannot attach to spontaneous timber growing. Nature, in this respect, is both accommodating and bounteous in her provisions. Waste places, as a rule, are utilized. Lands which, if at all adapted to other uses, could only be prepared at extra expense, are those nature occupies and renders of value. This growth comes of its own accord, so to speak, without preparation or labor by man, other than to guard against fires, along broken and often precipitous bluffs and ravines, in nooks and corners of tortuous and meandering streams incident to prairie regions. A belief is freely expressed that greater proportionate successful tree-growing, and at comparatively no expense, has been done by nature than by planting. As stated before, by a far

greater proportion of such planting and growing stands and succeeds than that of artificial processes. Losses are rare, and only from occasional invading fires, and, where too thick on the ground, the stronger kill out the weaker—no loss in fact—simply adjusting or equalizing. Personal knowledge is had of many instances where lands, twenty and twenty-five years ago, considered worthless, are now valued at from twenty to one hundred dollars per acre solely for the timber naturally grown.

ROBERT W. FURNAS.

BROWNVILLE, NEBR., *December* 1, 1882.

Walter Mulford
1897

DEPARTMENT OF AGRICULTURE.

MISCELLANEOUS. SPECIAL REPORT No. 5.

Walter Mulford

THE PROPER VALUE AND MANAGEMENT

OF

GOVERNMENT TIMBER LANDS

AND THE

DISTRIBUTION OF NORTH AMERICAN FOREST TREES,

BEING

PAPERS READ AT THE UNITED STATES DEPARTMENT OF AGRICULTURE, MAY 7-8, 1884.

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VALUE AND MANAGEMENT OF GOVERNMENT TIMBER LANDS AND DISTRIBUTION OF NORTH AMERICAN FOREST TREES.

THE VALUE OF AMERICAN TIMBER LANDS.

By Franklin B. Hough, *Lowville, New York*

This question lies at the foundation of the whole subject of American Forestry, and must largely influence the action of the owners of land, whatever they may do, in the preservation or planting of woodlands. The term "unimproved," which we apply to forest land, has come down to us from the pioneer as a synonym for "unproductive" or "unprofitable," and we sometimes hear of land being cleared because the owner "cannot afford to lay out of the use of it any longer."

We will attempt to point out the fallacy of these notions, and to show that an estate vested in woodlands, is neither unproductive nor unprofitable; but that on the contrary it is productive in revenue, reasonably safe as an investment, beyond the reach of speculative changes in value, and certain in its returns.

It may be remarked in the beginning, that since no lands have been hitherto reserved by our general or State governments for the maintenance and future supply of timber, and as the titles have passed to private owners, throughout the whole of the settled portions of the country—neither of these forms of government can have anything to do with the management of these lands. So far as foreign forest codes have reference to the management of woodlands upon the public domain, or upon estates owned by local communities or to public institutions, we can derive no aid from them, nor have we an interest in the jurisprudence that has arisen in the administration of these rights. From the simple and absolute tenure of our titles, we shall be for the most part wholly free from all the vexations and perplexities that elsewhere arise between landlord and tenant, or in the enjoyment of rights of common usage.

In some of the States, as in New York, certain tracts of wild land, once private property, have reverted to the State by failure of their owners to pay taxes. It is probable that these lands are very poor, and that the most of the timber has been cut off. Their reversion necessitates some plan of care and management, and questions of water supply and climatic influences are coming in with the arguments they afford in favor of legislative action in their behalf. But under these circum-

stances the question of present value or of future profits scarcely comes into the account, and will not be further considered on this occasion. The subject before us is, the ownership of woodlands by individuals, and the profits or losses that may affect their value, or operate as motives for their maintenance or their clearing.

It may be stated as a rule without exception, that the individual will govern his action as to woodlands as he does as to his fields, in the manner that will best serve his personal interest, and wholly without regard to any theories as to the effect it may have upon the public welfare.

It is further found, as the experience of the world, and it is especially true in our own country where the laws are made by those who are governed by them, that public control will not be tolerated in the management of private property, unless a public interest is to be protected thereby, and the reason of interference is just and evident.

We have before us another fact which is of the highest importance in this connection. We are at present wholly without any provision on the part of Government for the maintenance of woodlands upon the public domain, and as this domain is fast passing to private owners, there is not even a remote probability that any considerable part of the timber for the supply of our wants will ever be grown upon our public lands. If to this we add the fact that no foreign country has a surplus to supply us, we are led to the conclusion that whatever timber the future may require must be supplied from private lands.

It may require a crisis of want and high prices, the result of improvidence, to convince our people of the value of growing timber, but whenever such a time does come, the lesson will be learned and remembered, and our people will begin to see value in a growing tree.

We should seek to avoid the inconvenience and distress which scarcity and high prices would unavoidably occasion; and I regard the tendency of our "Arbor days," and school festivals in the interest of planting as in the highest degree beneficial—not so much for what is actually done, as for the effect it may have upon our young people, the scholars now in our schools, who will in a few years become the owners of our lands. It need not be said, for it is evident, that the planting and protection of groves and woodlands will not be undertaken by those who have spent a part of their lives in clearing land, nor by those who have acquired the notion that land has no productive value until it has been cleared.

The planting and care of woodlands leads to an appreciation and enjoyment of sylvan scenery, and every measure tending to the cultivation of rural tastes, is conducive to this end. We must first counteract the habit of destruction and waste which was acquired by the pioneer, or that has been handed down from him, before a beginning can be made. This is the first task in popular education before us, and it is eminently proper that it should begin in our schools.

As the land-owner will be governed by his own particular interest, with little regard for the general welfare, or the profit of others, he must be convinced that there is something to be gained by him in an enterprise before he will undertake it. As the returns of forestry are more or less remote, it will require a certain degree of foresight, of intelligence, and of faith in the future, in order to enable him to realize the prospects of the enterprise, and the extent and certainty of his returns.

In new industries where experience is wanting and experiment is necessary before success is assured it has been found good policy on the part of Government to encourage undertaking by bounties, premiums, exemptions from taxation, and other inducements for a limited time, and until the experience needed for successful operation had been acquired. It is by these means, and the further aid to be derived from experiment stations, scientific researches, and the diffusion of knowledge upon the subject, that the State governments may render the most substantial assistance in the advancement of Forestry.

As for bounties and premiums, their offer implies some competent and impartial agency for deciding between rival applicants. In the State of New York, in former years, the Judges of the County Courts, the Society for the Promotion of the Useful Arts, a Board of Agriculture, and the State and County Agricultural Societies have upon several occasions been empowered to examine and decide upon questions of this nature. There can be no question but that in the absence of State Forestry Associations the general or local Agricultural and Horticultural Societies throughout the country would be the best agencies for awarding these distinctions.

From the fixed and immovable nature of forest property, nothing could be done in the way of exhibition to the general public, excepting in the way of excursions, as is done by the Scottish Arboricultural and other Societies, but a great deal of benefit could be derived from the reports of visiting committees, statistical returns, and plain practical essays by competent and experienced observers and special agents. The best of these essays and reports should be rewarded by suitable prizes, and they should be widely distributed among those who would be most benefited by them.

In whatever manner these bounties or prizes might be offered, or any exemption from taxation in aid of planting might be allowed, it would not be good policy to make them unlimited as to time. A business that needs perpetual relief or support is a poor one, and if it cannot stand alone after fair assistance in the beginning it presents no inducement to enterprise; it will invite no investment of capital, and may as well be abandoned altogether.

In the recent discussions upon the forest question in New York, some have suggested the suspension of all taxes upon all existing woodlands as an inducement for their preservation. In my opinion this would be unwise and unjust; in fact, that it would not tend to the end proposed,

nor would it encourage planting. On the other hand, an exemption for a limited period, say from ten to twenty years, upon denuded lands when planted would tend directly to encouragement, and might itself, in many cases, present an inducement where nothing would have been done without it. In some States, as in Nebraska, where the constitution forbids the exemption of any kind of property from taxation, the Legislature has gone to the extent of its power in declaring lands thus planted as not liable to any increased valuation by reason of planting. This general or partial exemption from taxation for a limited time I regard as eminently proper; but beyond this it would afford just reason of complaint from the owners of property in other forms, and if enacted it would not long be endured.

In the Prairie States, where the want of wood was among the first to be felt, the settlers needed no arguments to enforce the motives for planting, and in these States we now find by far the greatest number of young plantations, and the most intelligence in their management. The facility with which lumber has been brought in by the railroads has relieved these sections of the country from an experience that would have been trying without them, and has doubtless limited forest-tree planting to a point far below what may hereafter be found a proper amount; but the beginning made is good, and the fault is only in its not going far enough. It admits of extension as the want becomes felt, and will doubtless be expanded hereafter as the demand and prices justify until it meets at least the local requirements.

In some instances the substitution of coal for fuel, and of iron for buildings, bridges, and naval architecture, has undoubtedly reduced very largely the consumption of wood and timber in the country. But it may be doubted as to whether these substitutions for wood have in reality tended to prolong our forest supplies. On the contrary, it has, by reducing the current prices, withdrawn the motives for longer maintenance, and upon many farms throughout the country the reserved wood lots have been cleared off as no longer needed for the family's use. Still these changes in the use of materials for fuel and construction are most fortunate, and they may be extended a great deal further with the greatest benefit. In Europe it has long ago been learned that not only the walls but the roofs and floors of buildings can be made of cheaper and better materials than wood; that wooden fences can be almost wholly dispensed with; that pavements and platforms of stone or brick are more economical and durable than those of plank, and that even iron railway ties and telegraph poles, although expensive at first, have advantages that, upon the whole, give them preference for use.

But however far these economies in the use of substitutes for wood may be carried, the demand is steadily increasing as a material for manufactures, and every year is adding the number of uses to which wood may be applied, and for which nothing else can be substituted.

The preparation of wood-pulp for paper; the distillation of acetates for chemical purposes; the multiplication of tanneries, and the increase of establishments for the making of railway cars, wagons, joinery, furniture, agricultural implements, and the innumerable other articles for which nothing but wood can be used, present a vast and growing demand upon our woodlands, which is steadily and surely reducing their area and exhausting their supplies.

At present prices, and upon highly fertile and arable lands, the grasses, grains, and fruits yield without doubt a more profitable return than could be realized from timber growth. But there are considerable tracts of land too broken and stony for cultivation that are in fact good for nothing else, but on which timber trees may be grown as well as if the surface were entirely smooth and free of stones. There are hillsides too steep for prudent pasturage, barren hill-tops that need forest protection, and ravines and river banks now suffering from erosions, that might be filled with woodland growth, without sensibly reducing the area that may be profitably employed in agriculture, and at very small expense.

In many parts of the country we find fields exhausted by improvident tillage, and often thrown out and abandoned as waste, that might be occupied by woodlands and restored in fertility by the annual decay of leaves. The exhaustion does not generally extend deep, and the subsoil will be found amply sufficient for the growth of forest trees. In places like these timber culture will pay, even at present prices, a moderately fair percentage, and almost without cost. In every case, however, it is profitable to give attention to a tract that is coming up as a spontaneous second growth. Poor and worthless species may be suppressed, and the more valuable kinds favored; a dense growth may be thinned out, and vacant places may be filled in without much expense, and with great profit in the end.

It need not be denied that large forest estates cannot be managed so as to produce large timber without an investment of capital, and that they cannot be held excepting by those who can afford to wait for the returns. Some of the great state forests in Europe are worked in periods of a hundred years and more, and the plans of management, the periods of thinnings, and time of final cutting are decided upon in the beginning, and are carried out without change to the end. The returns, although long delayed, are very large, and the interest upon the investment, above all expenses, is a reasonably fair one. The yield is several times greater than that of a common wildwood, with all its chances of injury from accident and neglect. If anything of this kind is ever seen in our country, it will probably be in the hands of some stock company or corporation, which, having acquired large tracts of broken land at a low price, may adopt the most approved methods for conducting their business, and may be able, as the market prices of timber may hereafter range, to divide a reasonably large surplus over all expenses.

It would be a great and positive gain if we could convince the owners of land (and it is unquestionably true and capable of proof) that planted lands, under ordinary conditions, have an additional value from the beginning, and that this value is increasing every year at a gaining rate. If the owner wishes to sell at any time, the land and the growth upon it will always command a price equal to the first value, added to value gained by growth. In many cases already the native timber upon wild land will sell for as much as the average farming land of the vicinity, leaving the land itself still in possession of the former owner. With proper protection from cattle and from fires, this same land in from thirty to fifty years, will have regained a similar growth, with whatever advantage there may be gained from advanced prices.

There are incidental advantages from the cultivation of groves and wood-lands interspersed among arable fields, and it might be shown that the farm crops afford a greater and more certain yield from the presence of woodlands between them. But with the present state of intelligence upon these subjects among the general class of our landholders, it is not probable that these considerations would have weight, unless entirely in accord with their own ideas of present or immediate advantage, nor can we ever expect any concerted and general action among them founded upon ideas of a public benefit.

The planting done hereafter upon private lands, must be visibly for the owner's advantage, and nothing else. It will not be done by a tenant, unless he is hired and paid for it; nor by the man of limited means, unless having special skill, he can find profit in selling his young plantations and undertaking others.

Under the present depressed condition of agricultural affairs in Great Britain, a suggestion has been made that the planting of forest trees might bring a better return than farm crops, as well as a benefit to the country. If this is true upon land where the raising of farm crops is possible, how much more so it must be upon lands now unimproved, but still suitable for tree-planting.

According to the last census, over 11 per cent. of the land included in farms is reported as unimproved—neither cultivated, pastured, nor in woodland, but waste. That this condition should exist in the prairie States and Territories, still but partly settled, need not surprise us; but 7 per cent. in Massachusetts, 6 per cent. in Connecticut, 3 per cent. in New York and Pennsylvania, about 3 per cent. in New Jersey, and so on of the older States, is too much; for in these States there are no tracts of dry land upon which trees of some kind cannot be grown.

As we cannot compel by law the private owner to plant, we must persuade him by pointing out the advantages to be derived from it—if not in returns that he can touch in his life-time—with certainty in an increased value in his property, whether sold or left as an inheritance to his family. The land-owner must be convinced that where he expends money or labor in planting he is putting these values at interest,

and that they will come back to him at certain future intervals of time, or at a fixed period, with these accrued values, or that their worth may be realized should he wish to sell. It is a work of popular education, through the various agencies by which public opinion is created or influenced, and upon these we must depend for whatever result may be obtained.

THE VALUE AND MANAGEMENT OF GOVERNMENT TIMBER LANDS.

BY N. H. EGLESTON, *Chief of the Forestry Division of the Agricultural Department.*

The value of Government timber lands, like that of all timber lands, is of two kinds. They have a value for their commercial products, such as lumber, bark, resins, seeds, &c. This value will depend upon the character of the trees growing on the lands, their kind, their abundance, their size, their accessibility, the facilities for obtaining their products, the distance at which they are from a proper market, and the character of the demand for them or their products. These, not to mention other considerations, must enter into any satisfactory estimate of the commercial value of any timber lands. This value of timber lands, therefore, will vary greatly with time and place. Fifty years ago, for instance, the great pine forests of Michigan had, we may say, no commercial value, because they were so remote from population, and, consequently, from market that there was no demand for what has since sold for millions and made thousands rich. Ten years ago the timber lands of Oregon and Washington Territory had little, if any, commercial value, for the same reason. Now, the completion of the Pacific Railroad, and the approximate exhaustion of the forests of Michigan, Wisconsin, and Minnesota have given a greatly increased value to those lands.

So, again, forests, composed of the best kinds of trees, may be growing on mountain sides of such altitude and so difficult of approach that they will not pay any one for converting them either into lumber or fuel. Or they may be growing in inaccessible swamps, and on that account will have no commercial value, and the lands sustaining such forests will have no market price.

But timber lands have another value besides that which is commercial, and this may be a higher one than any which can be measured by dollars and cents. This may be called their climatic and hygienic value, though in many cases it blends intimately with the commercial. The most careful and scientific investigations have shown beyond question that forests have a very perceptible influence in modifying climate. They have much to do with the temperature and moisture of the atmosphere in their vicinity and for a considerable distance from them. They influence the atmospheric currents. If they are not direct producers of rain they affect its distribution. They have much to do with the flow

of streams, and so with all the hygrometric conditions and influences connected with them. They thus become potent factors in determining the character of the climate of any particular region. They have, therefore, an important bearing upon health as well as upon the agricultural, commercial, and manufacturing interests of a country. Instances are not rare in which the removal of forests has been followed by insalubrity of climate and the restoration of the forests has been accompanied by its corresponding improvement. The destruction of the forests in many European and Asiatic countries has greatly lessened the agricultural productiveness of those countries. Lands once teeming with valuable grains and fruits have been made almost deserts by the destruction of the forests which once protected them. Streams which once bore the commerce of nations have ceased to be navigable, in consequence of the removal of the forests which formerly sheltered their head springs, while the navigation of other streams is becoming more and more difficult from year to year as the destruction of the forests, in which their head springs are situated or through which they flow, proceeds.

It is plain, therefore, that while some forests may have little commercial value, and on this account may be worthy of little notice, and may not be reckoned among the items of individual or of national wealth, they may be of the greatest importance in other respects and have a value so great that all the care and power of a nation may properly be called into requisition for their preservation. This climatic or meteorologic value of forests has only recently been recognized to any considerable extent, though individuals—the more thoughtful and observing—have seen it and taken notice of it to some extent from a very early period. But as it has come to be more widely recognized, especially during the last hundred years, and more particularly still during the last fifty, many of the European countries have made the management of the forests one of the most prominent and urgent duties of the government. In Germany and France, especially, this is the case. Laws most particular and imperative are enacted for the purpose of preserving existing forests or planting and maintaining forests where they have formerly been cut off, but where they are needed for climatic or other reasons affecting the public health or welfare. The individual landholder is not permitted to sweep away his forest trees at his pleasure, as he is with us, but, on the principle "*salus populi suprema lex*," he can only cut the trees so far and so fast as the authorities having this matter in charge pronounce to be consistent with the general interest, and then, usually, it is only on condition that a young tree shall be planted wherever an old one is cut. The forests belonging to the Government are managed in the same way, and while they are thus made conducive to the general welfare they are also made the source of large revenues. The budgets show that in the year 1883 Prussian Germany expended $8,128,625 in the care and management of her public forests, and received from the same, from the sale of lumber and

other products and the privilege of hunting and fishing, $13,092,875, or a net revenue of $4,964,250, while France during the same time expended 14,405,032 francs and received 35,768,900 francs, or a net profit of 21,363,868 francs, or $4,272,773 in round numbers.

Now, as to the value of our Government timber lands, to the consideration of which this paper is restricted, only an approximate estimate can be formed, for the reason that we know comparatively little about the timber lands belonging to the Government. Strange to say the Government has taken hardly any account of its timber lands. In the disposal of its lands the Government has gone upon the presumption that they would be used for agricultural purposes. In surveying them for the purpose of selling them, and so defining their boundaries that a satisfactory description and location of them could be given to the purchaser, they have been plotted by simple right lines, running north and south, east and west. The character of the land has been taken into account very little. To some extent the field notes of the surveyors give information as to swamps and wooded lands, but only a special examination by the contemplating purchaser could enable him to decide as to the real value of any piece of land. The vast amount of forests on the public domain, worth more than all its lands if cleared of timber, worth more than all the minerals within the ground, capable of yielding, in connection with private forests, products annually of greater commercial value than the largest cereal crop or that of cotton, the Government has taken no notice of. It has not regarded them as adding one dollar to its assets. It has put no higher price upon a section of land having timber on it worth thousands of dollars than it has upon a section of the poorest open land, destitute of tree or shrub, swept by the blizzards of the north or the siroccos from the Gulf and favored with so little rainfall as to forbid any profitable cultivation.

The only recognition of value in timber was in the early years of the present century, when the superior quality of the live-oak for shipbuilding induced some legislation on the part of Congress for the preservation of the limited amount of that timber growing in some of the Southern States, in order to provide a sufficient supply for the construction of our naval vessels.

In recent years, as great depredations have been made upon the public timber lands in other parts of the country, some efforts have been made to restrain them. But this has been done only to a partial extent, and by certain rulings and constructions by which the acts referring to the appropriation of the live-oak timber have been made applicable to other timber rather than by any express legislation designed to meet the case. The Government cannot be said to have taken any such action as would indicate that it regards its timber as valuable property, to be guarded and protected as property should be.

If it is asked, then, what is the value of the Government timber lands, the answer must be, we cannot tell, because the Government has not

even taken a proper inventory of its lands. It does not know how much timber land it possesses, nor what is its quality. We can estimate its value only approximately. In reply to an inquiry on the subject, the Commissioner of the Land Office says, "There is more or less timber in all the States and Territories containing public lands, but since such lands are not classified as to timber, the proportion of the same in each cannot be arrived at by this office."

Without, therefore, venturing upon any figures to represent the commercial value of the timber lands, inasmuch as we know so little as to the quantity of such lands or the quality of the timber growing upon them, we can only say, and this we can say with all confidence, that the estimated 84,000,000 acres of timber land still belonging to the Government must have a large commercial value. Some of it may be so situated as to have but little appreciable value now. But with the progressive settlement of the country and the increasing demands for lumber the value of such lands will be increasing rapidly. In Michigan and Wisconsin and in other States railroads are built for the very purpose of getting access to timber and bringing it to market. So a tract of timber which to-day has little if any appreciable value, may in twelve months, by the advent of a railway, be made more valuable than a mine of silver or gold. The commercial value of timber lands belonging to the Government is greater than that of similar lands belonging to private persons. The Government is under no necessity of disposing of its property within a particular limit of time as the individual owner usually is. It can wait for the fullest development of the value of its timber by the growth of centuries if need be. But this fact makes the more imperative the duty of the Government to protect such property both from injury and destruction.

As to the marketable value of the Government timber lands, while a portion of such lands, on account of present inaccessibility or distance from settlements or important commercial points, may have but little value, much of those lands are saleable, and would be in greater demand than they are were it not for the fact that forest fires render such property hazardous and that unscrupulous persons find it cheaper to steal timber than to buy it. The very fact also of the plundering of the Government timber lands proves, wherever it occurs, that the timber on such lands has a present market value. Men do not steal what has no value. Even the slight care which the Government has extended to its forests has resulted in the discovery that they have been plundered to the extent of several millions of dollars' worth of timber.

But apart from their pecuniary or commercial value, timber lands have a value which may be even greater, certainly more indispensable, than that. As modifiers and safeguards of climate, and thus having a bearing upon the health and comfort of the people and the productiveness of the agriculturists' fields; as distributors of rain-fall and regulators of streams, and thus having a bearing upon both commerce and

manufactures, they have a combined value which no figures can represent, but which is not the less, only greater, on that account. Their value in these respects is so great that their loss has been the ruin of nations, and if we are to maintain our prosperity as a nation we must maintain to a proper extent our forests. The tokens of coming trouble from the destruction of our forests are already visible. But the results of our rapid and reckless waste of them are not yet fully apparent. The complete effect of what we have done is not yet felt. Nature moves slowly. As we have been fifty years pursuing a course of conduct which has only in recent times so far developed its legitimate results as to excite our attention and beget alarm, so those results will continue to be developed for years to come, do what we may to remove the causes of them and to restore the former condition of things.

But this slowness with which natural causes work is the strongest argument for prompt and decisive action on our part. It will take years to arrest the evil results of our past action. We ought on this account to begin the work without delay, while past experience should teach us to refrain from repeating in other parts of the country the inconsiderate course of conduct which we have pursued.

As to the management of the Government timber lands, clearly there should be a change from the course hitherto pursued. It would seem to be the plainest dictate of common sense that the Government should recognize the fact that in its timber lands it has a valuable property besides the lands themselves, and that as a wise proprietor it should care for and protect that property and use it for its own highest advantage. Like a wise property-holder, it should first of all take an account of stock, ascertain how much of this forest property it has, and how much it is worth. At present the Government does not know, except in a very indefinite way, where or what its timber lands are. It does not know how dense its forests are, of what kind of trees composed, how situated, how valuable for one use or another. The first thing a private person claiming to own this property would do would be to refuse to sell any of it until he had carefully examined it, and, having thus ascertained its adaptation for various uses, had been able to form an intelligent decision as to its most advantageous disposal. Why should not the United States Government act in a similar way? Why should it not suspend the sale of its timber lands until it can make an accurate survey of them and ascertain their character and situation, and their value for one purpose or another?

Having done this, such of its timber lands as it would be desirable to have preserved in a forest state, for climatic reasons or on account of the favorable influence which they would exert upon the flow of rivers and streams, should continue to be withheld from sale, the timber growing thereon alone being sold, and that only by selection of the full-grown trees from time to time, and not all at once as has been the usage with the forests. The trees should be sold by Government officers, who

should be known as Forest Conservators, and the trees should be felled under their direction and in such a manner as not to injure the young and growing trees, and the place made vacant should be planted at once, so that the forest should be kept well stocked and in a growing, thrifty condition all the while. This is the way the Government forests are managed in Europe, and they are thus made an important source of revenue, while at the same time they are made the safeguards of public health, and promoters of the general welfare in many ways. So well satisfied are the people of the wisdon of this management, so convinced of the great importance to their welfare of an adequate supply of trees that the tendency is continually to increase the area of land devoted permanently to tree-growth instead of diminishing it, notwith standing the increase of population would tend to make inroads upon the forests in order to obtain additional land for tillage purposes. The people have become convinced that the most successful and remunerative tillage cannot be had without the aid and protection which the forests afford, while the trees are their best security against floods and droughts and devastating torrents.

A step in the direction of forest preservation has lately been made by the proposal to the Senate by Senator Edmunds of a bill for an act reserving from sale and protecting from injury a tract of about 7,000 square miles, mostly covered with timber, in the Territory of Montana, and embracing the head waters of the Missouri, the Columbia, and the Saskatchewan rivers. This proposal will meet the unhesitating approval of every member of this forestry congress, and it is to be hoped the equally unhesitating approval of every member of the National Congress. Once committed to the preservation of the Government timber lands for the public good, as it would be by such an enactment, we should be encouraged in the expectation that the Government would adopt other measures of like character, as from time to time they should be seen to be desirable, and that in due time we should become wise husbanders of our national forest treasures, instead of the reckless wasters that we have been.

Having thus ascertained what portion of our timber lands ought to be maintained in the forest condition and taken measures for its preservation as such, the rest might be offered for sale outright as our lands have been in time past, or the timber only might, in this case also, be sold, as it is in Canada, no trees being allowed to be cut that are of less than a certain diameter, and the land itself remaining still the property of the Government.

Such, it seems to me is the value, and such should be the management of the Government timber lands. Such a view of the subject implies a change, as has been seen, in the dealing of the Government in respect to its property in lands. It implies an increased expenditure in watching, protecting, and disposing properly of its timber lands. But there is no property of the Government so valuable as this, and therefore so

well deserving of expenditure for its protection and preservation. There is no property of the Government the care and protection of which will bring so large a return of profit to the State and of benefit to the people. It is estimated that the value of the annual products of our forests is not less than $800,000,000, outmeasuring the value of our great cereal crop, that of corn; more than that of our crops of hay, rye, oats, barley, buckwheat, potatoes, and tobacco taken together, and ten times that of all our mines of gold and silver. Can we be too considerate or too liberal in expenditure for the care and preservation of such interests?

THE VALUE AND MANAGEMENT OF THE TIMBER LANDS OF THE UNITED STATES.

By F. P. Baker.

It will be seen that the topic assigned me at this meeting refers not to the general forest area of the United States, belonging both to public and private parties, but that I am called upon to speak only of the forest lands actually belonging at this time to the National Government.

It would be naturally supposed that there could be nothing easier than to find in official records the answers to two questions embraced in the title of this paper:

1. How many acres of timber are owned by the Government; and
2. What are those acres worth?

Application to that well-informed and courteous gentleman, the Commissioner of the General Land Office, revealed the fact, however, that the Government of the United States does not know how much timber it owns, where it is located, or its actual condition and value. All the figures in the possession of the Interior Department are, at best, meager and approximate. This condition of affairs of itself justifies the existence of the Bureau of Forestry. There have, of course, been, volumes of reports on the subject of forestry in general of the United States, and of suggestions in regard to the preserving of the Government timber, but, as I have said, the report is still unwritten which contains a complete and satisfactory answer to him who would know the extent of those forests which are still under the absolute control of the Government.

The volume issued by the Public Land Commission, and entitled "The Public Domain," estimates that in 1880 the Government still retained 85,000,000 acres of timber valued at $2.50 an acre, which would amount to $212,500,000.

We are so accustomed to speaking of immense areas in connection with the public lands, that a hundred thousand or a million or so acres of land is considered a trifle, and in fact 85,000,000 acres is a small fraction of what was once the public domain, estimated at 1,852,310,987 acres.

Yet 85,000,000 acres of forest comprised in one body would make a very respectable "wood lot," particularly when, at a low estimate, it was considered worth $212,500,000. It is an area half as large as the State of Texas and more than three times as large as the State of Virginia. It may seem strange that any uncertainty should exist in regard to a possession so valuable, but it must be remembered that the Government has parted with a forest domain very much larger and more valuable without any special restraints or regulations conveying an idea of its special value. In disposing of the great forested States east of the Mississippi, forest lands were sold or granted at the same price or on the same conditions as any other lands. The Government never made any difference between forest and prairie, save that millions of acres of forest were disposed of, as if an incumbrance, under the vague title of "swamp lands." This is singular when we consider that the earliest settlers of the Western States set a great, in fact an undue, value on forest lands for purely agricultural purposes. The first value of the prairie was at first imperfectly understood in States like Illinois, and the pioneers clung to the wooded lands along the streams, and condemned themselves to years of hard work in consequence. Had the Government then placed a higher price on the timbered lands, it might have been better for all parties. The prairies would have been settled earlier and the lesson of the true use of forest taught in season.

The past, however, cannot be recalled, and the first question before us is, what is the extent and value of the timbered lands still in possession of the Government? And, growing out of these questions, what, in the light of past experience, should be done with them?

In the absence of official figures, we cannot say just where all these lands are located, or which lands are the most valuable. In our search for them we must be guided by certain generally known facts.

In the first place, it is, of course, understood that what are called arable lands in the older States are occupied, and that the Government lands remaining unsold or undisposed of in these States are broken, mountainous, swampy, or sandy barrens, and such lands are covered with forest growth of greater or less value. So of the 23,000,000 acres of land in the Southern States which the Government owns, the larger part may be supposed to be forest. And as these lands lie, for the most part, in the States of Florida, Alabama, Mississippi, Arkansas, and Louisiana, it will be safe to say that the larger part of these lands are pine lands.

The unsurveyed public lands lie in Minnesota, Nebraska, California, Nevada, Oregon, Washington, Colorado, Utah, Arizona, New Mexico, Dakota, Idaho, Montana, Wyoming, Louisiana, Florida, Indian Territory, and Alaska.

Within this region lies, beside the lands in the Southern States, what is left of the forest domain of the United States Government. The Government in 1880 owned in round numbers 28,000,000 surveyed acres

in Minnesota and 5,000,000 surveyed acres in Wisconsin, but these by this time may be considered as passed or rapidly passing from the control of the Government.

Of the territory containing lands still belonging to the Government, Nebraska and Dakota are prairie regions; Utah and New Mexico are, to say the least, not timbered countries. The Indian Territory is not open to settlement, and with its present inhabitants nobody, outside of it, is concerned about its future. The unsurveyed lands in Florida are in the Everglades and are inaccessible.

The timbered lands of the United States, then, in which the greatest interest should be felt are situated on the east and west slopes of the Rocky Mountains and parallel ranges in California, Nevada, Oregon, Washington, Colorado, Idaho, Montana, and Wyoming, and much the largest proportion in California, Oregon, Washington, and Colorado.

Here we have given in a rude way the location in two great bodies, or regions, of the 85,000,000 acres of forest, more or less, belonging to the United States.

The forest lands belonging to the Government in the Southern States are, and have been for years, for sale at $1.25 an acre, and for two or three years past have been in active demand, especially in Arkansas and Mississippi. An attempt was made some years ago to fix a price on and sell the timber land unfit for cultivation in California, Oregon, Nevada, and the Territory of Wyoming, but, while the price was set at the low figure of $2.50 per acre, in two years only 20,000 acres were disposed of. In a country where Government timber has always been stolen there has not yet sprung up an ardent desire to buy it.

But here is the timber. It grows on the mountain slopes at a height of 11,000 feet. Nearly all of it is fir, spruce, pine, and cedar. It is valuable enough to be foraged upon by miners, railroad-tie cutters, and charcoal burners. But much of it is inaccessible to the woodman, and yet it has a value, and that value is not to be estimated in dollars and cents. What shall be done with it?

If the Government should sell off its Southern pine lands at the estimated value, $2.50 an acre, and put the money in the National Treasury, the bargain might be a fair one. But if the Government should sell off its forests in the Rocky Mountains at $2.50 an acre, the condition, positive or implied, being that the forest should be at once cleared off, the bargain would be the worst ever made in the world.

In these mountains rise the Platte, the Arkansas, the Rio Grande, great rivers, and numberless small ones. On the existence of the forest on the mountain slopes depends the fact whether these streams shall, to use a figure, die or live. The question is one that once interested a few thousand people; it is one that now interests millions. The value of these forests lies not in what they will sell for in the shape of railroad ties or charcoal, but in their being the conservators of climate, the guardians of the snow, the reservoirs of rivers. Once the Rio

Grande and the Arkansas sent their waters through narrow ditches, painfully dug by the Mexican with his mattock and hoe, to water a few acres of alfalfa or of vineyard, but now these rivers are to play their part in mighty agricultural enterprises hundreds of miles from the mountains. There is in the course of construction in Kansas to-day one irrigating ditch 45 feet wide, to be, with its laterals, 200 miles long, and intended to water 500,000 acres, and this enterprise is only one of many such in progress in Kansas and Colorado, saying nothing of the canals already in existence in Colorado, Utah, and New Mexico. No estimate of the value of the forests on the Rocky Mountain slopes can be made without reference to the value of these irrigation enterprises present and to come.

If the Government could sell these forests for money at any figure, no matter how small, the case might assume a different aspect; but experience has shown that no sale can be effected. The only alternative offered the Government is, Shall the forests be stolen or wasted by careless fires, or shall they be preserved to be a priceless blessing? The slopes of the Rocky Mountains up to 11,000 feet of altitude will certainly never be taken up under the homestead or pre-emption acts, or sold for cash. The timber under the present system will suffer as before. It will be cut, stunted, girdled, burned. It will disappear, and the result will be desolation; the frequent land and snow-slides carrying destruction; the drying up of streams great and small; and the utter exhaustion of the supply of timber, now more than sufficient for the ordinary and reasonable uses of the local population.

Thus we have given in a rough way, a reference to rather than an account of, the forest domain of the Government. Now a few words as to its management.

That branch of the Government of the United States having charge of the public lands for the better part of a century and till within a very few years was conducted apparently in utter ignorance of the economic value of forests.

A few thousand acres of live-oak and cedar reserved for the use of the Navy, a general commission to land officers to prevent the unauthorized cutting of timber, if they felt disposed; this was all the Government did until 1877 to save for itself or the people such forests as grew nowhere else on the face of the globe. Since 1877 special agents have been employed to protect the timber, or rather to lock the stable after the horse is stolen, by prosecutions after the timber has disappeared. But a substantial advance has been made by the institution of the Bureau of Forestry, and it is to be hoped that intelligent action will follow the acquisition of knowledge.

The State of New York affords an illustration. The State had a forest domain in the Adirondacks. It suffered that domain to pass out of its hands and beyond its control. The woods were cut down and wasted, and for non-payment of taxes the desolated acres fell back into the hands

of the State. The question now is, "What is the value and extent of the forested and deforested domain of the State of New York." The loss the State has sustained by the altered flow of water in the Hudson and other streams is apparent enough, but the way to a sufficient remedy is full of difficulties. The objection rises at once, that in order to secure a sufficient area to conserve and grow the necessary forest the land of private parties must be purchased and that the State will be forced to pay exorbitant figures.

In the case of the Government this difficulty does not exist. Its ownership and control is absolute. The power exists to withdraw tomorrow every acre of Government timber land from sale or entry. In the case of the Rocky Mountain forests this should be done. If the preservation of the natural curiosities of the Yellowstone Park justifies such a course on a small scale, the preservation of the agriculture of New Mexico, Utah, Colorado, Western Kansas, and Nebraska justifies it on a large scale.

The "extent" of the timber lands of the United States should be maintained in order that their "value" may be increased. The forests should be kept, not given away; preserved, not wasted. The timber can be kept growing where it now stands, and be restored where it has been wasted. No citizen or honest settler or miner will suffer thereby. It is not necessary to his health, happiness, or prosperity that the fire shall leave the side of the mountain bare or that wealthy railroad corporations shall use stolen ties.

It is seen that when we come to speak of the "management" of Government timber lands we enter on a new field. There has been so far nothing that indicates the existence of a plan on the part of the Government having for its object the preservation of the forest still under its ownership and control. Under that head I would make a few suggestions:

1. Timber lands, properly so called, should be subjected to a different classification from arable lands, and the Government should, as soon as possible, cause such lands to be surveyed and described, so that it may be known where the lands are, the character of the timber, and their value.

2. Government timber should nowhere be sold at $1.25 an acre. If sold at all a price should be fixed upon it somewhere near its value.

3. Until the land is sold the timber should be carefully protected from spoliation by fire and timber thieves. This applies to pine lands in the South.

4. In the case of the Rocky Mountain forests the Government should at once withdraw them from sale or entry. Their destruction, authorized or unauthorized, is an evil for which there is no possible compensation.

5. The continued holding of the timber lands by the Government should be so regulated that waste, fallen, and surplus trees may be dis-

posed of for the absolute wants of the settlers; but no more timber should be slashed down, and no more railroad corporations be furnished ties at the expense of the Nation.

6. The care of the Government forests should not be left to the inefficient supervision of land officers whose present duties render such supervision impossible, but should be made the work of trained, competent, and honest men, commissioned by the Federal Government, responsible to and paid by it, and performing the work similar to the Government foresters of other countries.

7 The Department of Forestry, the duties of which are at present merely to collect information and give advice, should be organized into a working force, intrusted with the labor of classifying, describing, and preserving the Government forests, increasing their area, where practicable, by replanting and other means, and by bringing to justice those parties who trespass on the public timber lands, either in wantonness or for the purpose of plunder.

8. In connection with these labors it should be remembered that "knowledge is power," and consequently the training of a body of foresters should go on at Schools of Forestry and experimental stations to be established and maintained in different parts of the Union by the General Government. By these agencies also the whole theory of the effect of forests on climate, on the flow of streams, and other kindred matters should be carefully studied, and the result be made known to the public.

In the little Republic of Switzerland there is law enough and power to prevent the cutting of a single tree where its disappearance might make way for the avalanche. The Government of the most enlightened and powerful country on earth, if we may believe its orators, is certainly strong enough and wise enough to prevent the spoliation and wasting of its own property.

I have given in a very general way my views of the value of a great property belonging to the people of this country, and I indulge in the hope that the Government will continue to collect the facts concerning the great interest in some convenient and accessible form, so that some future investigator may be able to speak to you in a more detailed, accurate, interesting, and instructive manner than I have been able to do.

VALUE AND MANAGEMENT OF GOVERNMENT TIMBER-LANDS.

By B. E. Fernow.

This question involves the determination of the problem as to whether consistently with the maxims of true statesmanship the State or Government *ought* to own and manage any lands except so far as they are absolutely necessary to its existence, or until it can properly dispose of them to settlers.

We agree that, as a rule, the management of all economies is much better performed by private individuals than by the State; in fact, that it is undesirable for the Government to engage in any mercantile business, and therefore we would reject any arguments for the retention of Government forests, solely drawn from financial considerations. Such reasons, as the assurance of a safe and constant revenue to the State from forest property, and therefore the possibility of a reduction of taxes, the power of controlling and maintaining the timber supply, the opportunity in cases of emergency of raising loans on such property, all such considerations must only be allowed as secondary and will eventually help to strengthen our argument in favor of Government lands.

If the forests of a country were nothing but ordinary property, just as a house, a mine, or a farm, we would contend, that the State should not own and manage forests, that their utilization should be entirely regulated by the effects of supply and demand and agreeably to the individual interest of the moment, which, according to Adam Smith, is the only rightful motive in the use and disposal of property. But there are properties over which the right of eminent domain would be allowed to the State even by the most radical economic reformers. Such things as are of importance to the safety, well being, and happiness of the whole community, like the air, the waters, streets and roads, cannot be entirely given up to individual disposal without injury to a large part of the community.

The experiences of nearly every European country during the first decades of this century have practically proved that the liberation of forest property from all restraint—while, according to Smith, it should have led to the highest economic development—has bred devastation and destruction not only to the property from which the forest had been wantonly removed, but to the agricultural interests and economic prosperity of the whole surrounding district.

Modern investigations have left no doubt that the presence or absence of certain percentage of woodlands has a decided influence upon the climate of a country; modern experience has taught that the destruction of forests on headwaters is apt to paralyze the regularity of the water-supply and at enormous cost to communities has bred alternate floods and droughts.

History of all times and nations has shown that by wanton abuse of forest properties industries have been destroyed, agricultural lands have been laid waste, civilized districts have been made uninhabitable and turned into deserts and the inhabitants have been reduced to poverty.

It is a peculiarity of systematic forest economy that it must work with a large capital stock of timber, which, accumulated through long years, may be utilized at any time. Therefore an increased demand for lumber may be satisfied by diminishing the capital stock. The financial interests of the private forest owner will in most cases induce him to use this

means of meeting the increased demand, and to take advantage of the higher market price rather than to increase production by more extensive plantations. These would only after many years yield a useful material, and therefore the advantageous market price, stimulated by present demand, might not be secured. Forest devastation is then the natural consequence of the application of this rule of demand and supply.

Recognizing, then, the significance of the climatic and hydraulic influences of the forest, it will become necessary to revise the principles of statesmanship which treat of State property and of the relation of the State to forest owners. Where the common weal and the economic development of the whole community is concerned, the Government must have the right and the duty to exercise eminent domain and to interfere with the use of this class of property. But there will always be a strong feeling against the exercise of such right on the part of the State; even the republican spirit of the free citizen will rarely be exalted enough to allow interference with his property rights for a benefit to the community, which he may not even recognize.

It will, therefore, seem advisable that the State itself should own those forests, the existence and continuance of which as such, is necessary for the agricultural and general interests of its citizens. Since these lands are mostly unavailable for any other purpose than forest growth, since forestry on such lands is by no means as profitable a business as a private individual would care to carry on, and since by a management of these forests under Government a continual timber supply is guaranteed to the surrounding country, it should not be a difficult matter to retain or else to acquire such property either in the way of regular purchase, based on tax valuation, or by expropriation in consideration of public interest.

From the foregoing remarks it will appear that the value of Government timber lands cannot be ascertained on such basis as that of ordinary property of private individuals and on mercantile considerations only. The value of this kind of property is of a higher order. It is not equal to the value of the crop or the productive value of the soil, nor to the combined value of these two factors. Their value is not represented by the selling value of either or both.

Where the land is held for purposes of colonization the price ought to be far below its real or market value to *actual settlers*, in order to offer an inducement. But where forest land is held by the State for considerations of public welfare, as pointed out before, its value is *incalculable*—and as to price, it should be out of the market altogether. If managed on true scientific and systematic principles, such forests will attain the additional value of educators, serving as a school and example to private forest owners.

In Prussia, where only one-fourth of all the forests is held by the State, the large class of private owners have greatly benefited by the example of the Government and availed themselves of the experience

and advice of the officers, educated for the Government service, and systematic management with a view of continuity has become the rule.

Which of the lands now in possession of the General Government fall under the first class—held for colonizatory purposes—and which should be classed under the second, it is impossible to determine without at least an approximate forest survey. Such survey may easily be made in connection with the geodetic surveys and geographical explorations already established, and need not go into further details than locating and mapping in approximate measurement such districts, which should be exempted from sale on account of their unfitness for agricultural use or for reasons of their climatic, meteorological, and hydraulic influence.

Care should also be taken not to dispose of any lands except to settlers, and that no lands be sold which are only fit for forest growth.

By making sales to settlers subject to a condition, requiring them to keep a certain part of their entry in forest under the supervision of the nearest Government forest officer, an intelligent class of small forest owners might be quickly educated. In the management of Government timber-lands the financial effect should be only secondary, and the continuity of the forest should be of more account than the demands of the lumber market.

I do not advocate an expenditure of money for the purpose of keeping forests intact; but I believe that a Forest administration for the Government timber-lands, either of a State or of the United States, can be devised and maintained, and that at this present day, which will not only pay its own expenses from the sale of ripe timber, but which, besides answering all the purposes of protecting our water supply and our climatic conditions, will yield a handsome revenue and furnish sufficient means for acquiring and reforestating such localities as should be preserved in forest.

What methods should be applied in regard to the details of management it is now too early to discuss.

The present meager appropriations of the General Government are but a drop in the ocean, and are more likely by their insufficiency to bring discredit on those who attempt to accomplish with them anything of value than to promote very much the forest policy of this country.

It seems a short-sighted policy, indeed, which neglects to take proper care of so valuable a property as the forests of the public domain now are, and which could be made much more valuable by proper management. Until recently, according to the Commissioner of the Land Office, the depredations on this State property must alone have amounted yearly to several million dollars, of which only a small part, at heavy expense, may be recovered, whilst the inauguration of a Forest department, with a view of actually managing the domain according to the principles laid down before, would cause the dead capital stored in these forests to pay the interest on any appropriation which might be made for it.

The following figures, from the Forest administration of Prussia and other States of Germany, a country in which the Government forests are notably very excellently managed, on the most conservative principles, may serve to form an idea what such an administration can be expected to yield.

The total area of Prussia comprises 89,000,000 acres. Of the 23.3 per cent. of forest land, the State owns only 29.4 per cent., representing an area of 6,000,000 acres. The administration of this area* with all its incidentals, as forest schools, experiment stations, &c., required a force of officers of different grades, and guards numbering nearly five thousand; the expense of this part of the administration amounted to nearly $3,000,000.

A large force of laborers, having the benefit of work all the year round, is employed in planting and lumbering.

The cost of lumbering and expenses of transportation amounted to		$1,750,000
For cultivation, improvements, roads, &c		1,000,000
For taxes and other obligations		250,000
Total expenditures		6,000,000
Or $1 per acre.		
Receipts for timber and cordwood	$12,250,000	
Other revenues	1,000,000	
Total receipts		13,250,000
Leaving a net profit of		7,250,000

This result, representing a net profit of 52.5 per cent. of the receipts, has been obtained by selling the ripe wood at an average price of not quite 6 cents per cubic foot in the woods. In recent years the expenditures have been increased by buying up waste lands fit only for forest culture. To show how this record of poor and economical Prussia compares with other German administrations we have compiled the following figures:

In the year 1882, the following results were obtained for 1 acre of forest land:

	In fourteen States (average.)	In Bavaria.	In Prussia.
Total receipts	3.04	3.88	2.08
Expenses of administration	0.52	0.54	0.46
Other expenses, lumbering, &c	0.60	0.60	0.44
Total expenditure	1.12	1.14	0.90
Net profit	1.92	2.74	1.18

It may be interesting to know the result of the forest administration of so small a State as the little dukedom of Saxe-Gotha, which has just come to hand, for the year 1882. Its forest area is only 80,000 acres, of

* The following data are compiled from the official reports, and represent averages during the years 1870 to 1879.

which 78 per cent. are in fir and pine. The cut for 1882, was 22,000,000 feet of logs and 18,000 cords of firewood.

The receipts from this were $382,000, or 10 cents per cubic foot. Other revenues brought the receipts up to $386,000, or nearly $5 per acre. The expenditures were—

For administration	$49,000
For roads	10,450
For cultivation, for which 760 acres or 0.95 per cent. of the forest area were replanted	8,300
For lumbering	73,600
For surveys, destroying of insects, &c	7,000
Total expenditures, or $1.85 per acre	$148,350

Therefore net proceeds $237,700, or $2.97 per acre; *i. e.*, 67.1 per cent. of the receipts.

THE PRESERVATION OF FORESTS ON THE HEADWATERS OF STREAMS.

By M. C. Read.

The Mississippi Valley has an extreme breadth of over 33° of longitude, and a length of over 20° in latitude, embracing more than one-half of all the territory of the United States.

The Mississippi River stretches its arms from east to west until they embrace in their grasp nearly one tenth of the earth's circumference.

If in this valley were gathered all the Caucasian race, there would be a population of only about 370 to the square mile; and if all the inhabitants of the earth were gathered into it, the population would not overcrowd it. Its fertility is almost as unexampled as its size. Deducting the arid portion of the West, there is nowhere else on earth an area of one-half the size of unbroken land of equal fertility and productiveness, or capable of supporting so dense a population. The question of the future of this great valley is of so vast importance that imagination can hardly grasp it. Shall the arid climate of the West creep steadily eastward, till its hot breath parches the slopes of the Alleghany Mountains, or shall our tillage, with ever increasing returns, be extended steadily westward till it reaches the base of the Rocky Mountains?

Man is now the potent agent in geological and climatic changes. He is profoundly modifying the whole of the surface of the earth. He has changed the vast territory of western Asia, whose agricultural products once supported the dense populations that lived under the ancient monarchies, into an almost desert waste. The wise Solomon and his ally, King Hiram, in the destruction of the cedars of Lebanon, commenced a work which has rendered a land once flowing with milk and honey almost barren.

If our work in the great Mississippi Valley is having a permanent effect upon its future fertility we cannot scrutinize too closely the character of that work and its tendency.

We are tenants for life only of this vast inheritance we have received from our fathers. The remainder-over belongs to those who are now unborn—to whom we are bound to leave it with its productiveness unimpaired. Each life tenant is too prone to disregard the rights of those entitled to the remainder-over, and to make what he can from his tenancy, regardless of its effect upon the future value of the estate. When the prophet warned good King Hezekiah, that after his death all the treasures of his home should be plundered and his sons carried into captivity and dishonored, he wrapped the mantle of his own selfishness around him and said, "Is it *not good* if peace and truth be in my day," although fully advised that the coming calamities were the result of his own misdeeds.

In the unadvised and unrestrained acts of the life-tenant the rights of the remainder-men are never safe. A little immediate advantage far outweighs all future and contingent evil. And right here is one of the most important duties of every Government, which it cannot neglect without being false to its most important trust. It is bound to thoroughly enforce that wise maxim of the law, that each one "shall so use his own as not to injure another," and to include in that word "another" all who shall come after him. Government is the trustee of the future proprietors, and is bound to take all action which may be necessary to secure to them their rights, among which is the enjoyment of their inheritance with its productiveness wholly unimpaired. A failure to do this has not only destroyed great empires, but has left the land in such a condition that it could not support a great empire.

It is regarded as demonstrated, that in a wide area of agricultural land, when one-fourth of it is retained in forests, the residue will, year by year, yield more agricultural products than the whole would if cleared and subjected to tillage, and there is no other place in the world where the danger from forest destruction is so great as in the Mississippi Valley. At the headwaters of most streams nature has provided for the perpetuity of the forests, by leaving the land in a condition unfitted for anything except forest growth, and when the streams and the valleys are small, these lands, condemned by nature to forests, may suffice for all climatic influences. But the area of tillable land in the Mississippi Valley is so immense, and the temptation to forest destruction so great, that we are in danger of being ruined through the very munificence of nature.

Practically the whole of this valley is capable of being put under tillage, and personal greed is tending to this result, and very clearly is tending to its *diminished* fertility and quite probably to the complete *destruction* of its fertility. A possible result so appalling cannot be contemplated without serious apprehension.

But climatic influences are so slow in their action, taking so long a time to demonstrate their tendency, that it is a hard task to persuade more than a very few of their real tendency.

But the attempt to put certain lands under tillage which nature reserved for other uses has already produced most disastrous results, which, it is believed, will be recognized by all as soon as pointed out, and it is to our errors in this respect that this paper will be mainly devoted.

The sources of nearly all the tributaries of the Mississippi are found in a series of swamps and lakelets, which, receiving the drainage of adjacent higher land, furnish a perennial flow of water as the commencement of each tributary. The gentle divide which separates the waters of the Ohio from Lake Erie is dotted with such swamps and lakes. A map on a large scale of Northern Wisconsin and Minnesota exhibits as its most marked characteristic a multitude of such lakes; and in the mountainous regions of Pennsylvania and Virginia elevated swamps or lakes are found at the heads of very many of the streams. Taking the whole of this great valley and as a rule, to which there are only few exceptions, the beginnings of the streams are in swamps and lakelets.

Their function in the drainage system of the valley is best understood where man has not interfered with it; where the lakes are often surrounded with marshes, generally with forests containing a dense undergrowth of shrubs and sphagnous mosses, where the swamps are almost impenetrable, filled to a great depth with a peaty growth which in places has bridged over and covered a buried lake, receiving the drainage from a large surrounding wooded area, the outlets of swamps and lakes alike choked with a dense growth of aquatic plants, all constituting a series of reservoirs from which the water runs off slowly, from which there is a large evaporation, and from which the downward drainage into the soil and the deep rock strata below is never interrupted.

Their presence turns back by evaporation into the air much of the rainfall, fills the rocks below with subterranean streams, which are the sources of all the perennial springs, and so regulates the outflow of the surplus water as *tends* to maintain an equable flow throughout the whole year. If these natural reservoirs were large enough this result would be obtained, the flow of all the streams would be substantially uniform, and we should never hear of destructive floods on the larger streams. The flow of water in Detroit and Niagara rivers is substantially uniform, except as the level of the lakes above is changed by the force of the wind.

These primitive conditions have been greatly changed. The clearing of the higher land has caused the surface water to flow more rapidly into these lakes and swamps.

When it was learned that if reclaimed the swamps would constitute some of our most productive lands, the work of their extermination was commenced and pushed with vigor. In most States ditch laws were

enacted, by which a majority of the owners of any body of swamp lands could compel the others to contribute their proportion to the systematic drainage of the whole.

The surface of the swamps being generally found on the same level as the surface of adjacent lakes, it was found that the outlets of these must be deepened and broadened, to secure the drainage of the swamps, and to provide for the prompt outflow of the water which now, without any retardation, found its way into the swamps and lakes.

To accommodate this more rapid outflow, the streams below have been often straightened, obstructions removed, and the rapid concentration of the water into the larger streams made as easy as possible. In much of the remaining forest the destruction of the large timber trees has made openings for the sun, the underbrush has been destroyed, the intrusion of domestic cattle has carried the seeds of the grasses, and these wood lots are being converted into wood pastures. All these agencies combined are making the surface drainage almost as perfect as if a series of impervious roofs covered the land and all the flow from them was conducted by pipes into one common channel.

The results are not matters of speculation, but can everywhere be observed. Springs once copious have disappeared; streams formerly perennial alternately overflow their banks and run dry. The natural regulators of the streams having been destroyed, whenever there is an excessive rain it is rapidly carried into the streams which, gradually uniting their waters, often constitute floods in the larger channels which no human appliances can control. By a system of dikes and levees we may do something to check the evil for a time, but we shall certainly make it greater in the future. The stream confined to its channel will deposit sediment upon the bottom, gradually raising it above the level of the adjacent land, and then when breaks occur in the dikes the results will be unspeakably disastrous.

This work of destroying the natural regulators of our streams and cutting off the sources of supply for the springs, is not wholly accomplished, but is pushed with vigor every year. Additional swamps are reclaimed each year, the drainage in all made more perfect, the soil compacted by continual cultivation until it loses entirely its spongy porous character, the wash of sediment into the lakes is greatly facilitated by the clearing and cultivation of the adjacent land, so that by a steady silting up of the bottom, and by the enlargement of their outlets, their capacity is rapidly diminished and their future obliteration rendered inevitable, unless something is done for their preservation.

The future results are not uncertain. Every succeeding year a definite rainfall in a given time will result in a more destructive flood than ever before. A drought of the same duration will leave more and more of our streams without water, and springs which have heretofore been perennial will cease to flow. Our wells will not escape the results of these influences, and more of them will go dry.

There is but one possible remedy for all of these evils. It is for us to cease to do evil, and to learn to do well; to hasten as quickly as possible to undo our work and recreate the natural reservoirs we have destroyed. By reforestering these swamps and the higher land which surrounds them and the lakes, we shall restore them to their proper place in the economy of nature. The abundance of moisture will make this work comparatively easy, as it will insure a rapid growth of trees and shrubs. Swamp oaks, white maple, black ash, tamarack, and pine are among the valuable trees that find a congenial home in all such swamps. For the higher ground around, other valuable trees should be selected. But it is not alone what are called valuable trees whose growth should be encouraged. In all forest culture it should be remembered that, for climatic purposes, an orchard of forest trees is not a forest. The planting of trees along the highways, about our homes, in parks and groves, ought to be encouraged for a variety of reasons, but will have little of the climatic effect of true forests. A dense growth of underbrush, herbaceous plants, and mosses under the larger trees, which will retain the fallen leaves in place, fill the surface soil with rootlets, checking the flow of water and facilitating its entrance into the earth, are essential parts of a true forest. They also tend in all seasons to maintain that moist condition of the soil and air which is essential to the vigorous growth of the larger trees. Fortunately a multitude of such shrubs and plants will spring up on all this swamp land as soon as it is devoted to forest growth and protected from the intrusion of domestic animals.

The lakes should be restored to their former dimensions, and wherever practicable enlarged by damming their outlets. Fortunately the attention now given to the artificial propagation of our food-fishes favors this work. It is claimed with a good probability of truth that a lake well stocked with fish will produce as much food as the same area of land devoted to the raising of ordinary field crops, and it is more than probable that the annual forest growth of the swamps and the fish products of the lakes combined, will be of much more value than the agricultural products which can be obtained from the swamp lands alone.

But the prospect of immediate returns, with most men, so far outweighs the advantages of prospective greater returns, that few, without some additional inducement, will be persuad ed to devote to forest growth the swamp lands which they have fitted for tillage with so much labor. While they know that they are not permitted to so drain their lands as to flood injuriously the land of an adjacent proprietor, they will ask, "Why shall I abandon what seems to me the best use of my own land because of supposed injury to those who are thousands of miles away?" The injury is so remote, and the responsibility so divided, that no one feels personally responsible for his share in the results. Governmental aid, State or national, in the way of bounties, exemption from taxation, or in some other mode, is essential to the securing of the devotion of these

lakes to fish preserves, and of these swamps to forest growth. The people at the head of the streams readily consent to be taxed for the really fruitless and irrational work of constructing dikes on the banks of the Mississippi; and the time will certainly come when those now injured by the floods will turn their attention to the real causes of the evils they suffer, and will gladly consent to be taxed for the purchase and governmental control of all these lakes and swamps. They will see that the only remedy for the calamities they encounter is to *regulate* the flow of the water in the river, instead of attempting to control it when it has become uncontrollable.

The restoration of these natural regulators will not accomplish all that is desired. It will be an important step in the right direction, and a reliable guide to supplemental efforts; for the waters of the Mississippi and its tributaries are as thoroughly under our control as is the water supply of any great city. We can prevent *all* destructive floods, and secure such a uniform flow as will prevent any interruption of navigation in the principal tributaries during the most protracted drought.

In 1849 Charles Ellet, a civil engineer, contributed to the Smithsonian Institute a paper, which was published in the second volume of its Contributions, "On the physical geography of the Mississippi Valley," the object of which was to outline a plan for the improvement of the Ohio River by securing such a constant flow of water as would prevent all interruption of navigation. This problem he solves, and he incidentally solves the problem of the means of preventing all destructive floods.

He gives, in a series of tables, the daily flow of water over the Wheeling bar for a number of years, and figures the capacity of reservoirs at the head of the streams which, filled at the time of heavy rains and retained until needed, would suffice, in times of natural low water, to maintain a sufficient flow over the bar to prevent all interruption to the navigation of the stream.

He computes also the volume of the destructive part of the water of the great flood of 1832, when the water rose at Cincinnati to the height of 63 feet above low-water mark, and demonstrates the practicability, at a comparatively trifling expense, of so controlling it, and all other similar floods, as to make them absolutely harmless.

On page 48 of his paper he says:

> Although in this paper the computations have only been made to the reduction of the extreme height of the flood mark, so as to show that it is quite practicable to render it harmless, there are many interests in society which would be promoted by a further extension of the system and an ultimate approach toward an equalization of the daily discharge. It is quite reasonable to suppose that in course of time all the waters of all the navigable rivers will be required to supply the wants of man and his commerce. Reservoirs may eventually be made of sufficient capacity to hold *all* the annual excess and make the daily flow almost entirely uniform. The banks of the Ohio and Mississippi, now broken by the current and lined with fallen trees, ready to be swept by the next freshet into the channel, there to form dangerous snags, may yet in the course

of a very few years be cultivated and adorned down to the water's edge. In the opinion of the writer, the grass will hereafter grow luxuriantly along the caving banks. All material fluctuations of the water will be prevented, and the level of the river surface will become nearly stationary. Grounds which are now frequently inundated and valueless will be tilled and subdued; the sand-bars will be permanently covered, and, under a uniform regimen of the stream, will probably cease to be produced. The channels will become stationary. The wharves will be built as the wharves on tide-water, with little if any reference to the fluctuations of the surface. The lower streets of all the river towns, no longer exposed to inundations, will acquire new value. The turbid waters will be arrested in the upper pools, and the Ohio first, and ultimately the Missouri and Mississippi, will be made to flow forever, with a constant deep and limpid stream. The ice will be swept off as it forms, and neither cold or droughts will longer be suffered injuriously to affect the navigation. The ocean steamers will not then be confined to tide-waters, but will be able safely to ascend the living streams to sea-ports on their borders, and the extent of the inland navigation will be limited only by the limit of the water which is supplied by the atmosphere.

All this may be accomplished on the Ohio *for about the cost of three or four ships of the line.* The great and only difficulty is to overcome the cold incredulity of the public, so as to induce those in power to grant a sufficient appropriation for the completion of the first two reservoirs. This once accomplished, and a single practical demonstration made, it will be difficult to convince the future engineer that a thing so clear and palpable could ever be doubted.

As an effort of art, the work of controlling the floods of the great rivers of the Mississippi Valley will never compare with the labors of men in other departments of practical service. More money has been laid out on 3 miles of railroad than would be needed to maintain the waters of the Ohio within 2 feet of a uniform height throughout the year, to add a length of several hundred miles to the river navigation of the country, and render more than 2,000 miles of precarious navigation permanent and certain. The same reservoir that keeps back the excess of water from the tributary keeps it back also from the recipient stream; the same supply that maintains the navigation of the tributary also improves that of the recipient; and the same reservoir that serves to maintain the navigation of both tributary and recipient, serves of necessity to protect both from overflow.

These things will be effected, not by main force but by skill. The rain-gauge will indicate the approaching danger from the summits of the distant mountains; the telegraph will announce the fact at the flood-gates, and the whole may thus be controlled by the previsions of science. In fact the desired effect can be produced by a few dams in the mountain gorges, and the constant attention of some twenty men.

On page 54, speaking particularly of the improvement of the Ohio, he says:

It has been the duty of the writer, at former periods, to conduct surveys along a considerable portion of the Upper Alleghany and the whole of the Great Kanawha, and to become familiar with the character of the Monongahela as far as it is susceptible of improvement. Aided by this personal knowledge and the facts acquired in the present investigation, he hazards the opinion, that less than $1,250,000 will suffice to supply the Ohio with a depth sufficient for boats of 5 feet draught; to carry on open and permanent river navigation during three-fourths of the year, from Franklin to the line of the Erie Railroad in New York; improve the navigation of the Monongahela into Virginia, and extend that of the Kanawha 70 or 80 miles above Point Pleasant—supplying water-powers of unrivaled capacity and permanence on numerous lines of steamboat navigation, and curbing most essentially the destructive power of floods.

Viewing the insignificant cost for which about 1,400 miles of river navigation may thus be rendered permanently available—without reference to the incidental advan-

tages that will flow from the work—it may well be doubted whether there is, in the whole circle of contemplated public improvements, a projected enterprise which more seriously demands the care and consideration of those who are charged with the protection of the public interests.

The difficulty which the mind first encounters in contemplating this proposition arises from the apparent immensity of the mass of waters to be dealt with. But this is only a speculation. The quantity has been *measured* and found to be easily attainable and perfectly manageable.

The total discharge of the Ohio, in ordinary low water, is but 6,000,000 cubic feet per hour. A pipe no larger than one of those used for conveying the water of the Croton water works—or 3 feet in diameter—will discharge very nearly 1,000,000 cubic feet per hour, under a head of 60 feet. Six such pipes, then, placed in a dam only 60 feet high, and provided with proper valves, would emit water enough to double the quantity flowing down the Ohio at its usual summer stage. And if there were three such dams, on different streams, and twelve pipes in each, and one man to superintend each dam, and obey the telegraphic signal to open or close the valves, or an equipment equal to three dams, no higher than have already been built in this country, and thirty-six pipes, equal in diameter to the mains in Broadway, and three men to manage the whole, the quantity of water could be increased sixfold, and the navigation could be maintained above 5 feet during all ordinary droughts. At the same time, such is, happily, the form of many of the Western valleys, that dams of double this height can be often erected without injury, to any appreciable amount, of property improved or susceptible of improvement.

While the author probably underestimates the cost of these improvements, he certainly demonstrates their practicability, and at a cost very much less than the damages resulting from a single great flood.

The great excellence of this system is that it supplements the agencies which nature provides to subserve the same ends, co-operating with them and extending them. The work accomplished by the natural lakes and swamps, which has already been outlined, would also be accomplished by these artificial reservoirs, and to a degree exactly proportioned to their relative size. A large percentage of the retained water would be carried deep into the earth, establishing subterranean streams, from which copious perennial springs would be produced, while from their broad surfaces an additional amount of water would be evaporated into the air, to be again precipitated in refreshing showers.

Artificial lakes thus formed at the headwaters of the Missouri River would load with moisture the dry winds sweeping over them toward the plains, where it would probably be often deposited in copious showers; the seepage downwards would find underground channels which here and there in the plains below would break out in perennial springs and to some extent, at least, convert a desert into fruitful fields.

It has been the dream of some that the time was coming when copious showers could be called from the heavens at the will of man, and injurious droughts become unknown. This is doubtless only an utopian dream, but the rain that does fall is subject to man's control. He may utilize it all to his advantage; during excessive rains he may hold back all that part of it which without his interference would constitute an injurious flood, and with that thus retained maintain a perennial and nearly uniform flow in all the streams.

With a proper amount of restored forests, with our natural reservoirs enlarged and preserved, and artificial lakes established at the heads of the streams of a capacity sufficient to regulate their flow, evaporation would be largely increased. We should attack the arid plains of the West upon both flanks at once, and if our agency can convert them into fruitful fields it will be accomplished in this way. It is certain that our work hitherto has tended in the opposite direction. Our hastening the downward flow of the water, has tended to diminish local evaporation, our destruction of the forests local precipitation, and, if continued, there is great danger that the line which marks the eastern margin of the arid region will move steadily eastward until it crosses the Mississippi, and, perhaps, checked by no barrier, until it reaches the base of the Alleghanies.

These probable results, involving on the one hand calamities so appalling, and on the other benefits so far reaching, demand the most careful consideration on the part of the science and the statesmanship of the whole country. It is a question of vastly more importance than all the questions upon which political parties are formed, and which, if properly appreciated, would make those questions seem in comparison childish and of little account. In the destiny of the Mississippi Valley is involved the destiny of the whole American people. It feeds the cities and manufactories of the East, and the mining towns and centers of the West, while it largely absorbs the products of both. It is a fitting time to inquire in regard to it, What are its tendencies for the future? Clearly those tendencies now are in the wrong direction, a tendency to an ever diminishing power of production which will end, we know not where. Statistics of crop productions will tend to mislead us. Every year an immense territory of virgin soil is subjected to the plow, and improved modes of culture are increasing the products of the old farms, but it is not what it in fact produces, but what it is capable of producing and will be capable of producing in the future, that is to be considered in this discussion, and there can be no doubt that present influences are seriously threatening its future power of production.

Toward resisting this tendency something may be done by individual efforts, by warning, by appeal, by disseminating a love for forest culture, and a just appreciation of its monetary value; by our Fish Commissioners, encouraging the appropriation of all small lakes and ponds to the artificial rearing of fish; by our State legislatures, by premiums, bounties, exemption from taxes, or in some other way securing the reforesting of the swamps and hills at the heads of all the streams; and by the General Government supplementing all this work in the way proposed by Mr. Ellet in the paper already quoted. While the certain direct results, in improved navigation and immunity from floods, and the probable results in climatic influences, would pay a thousand fold for the money required to equalize the flow of water in all the larger streams of the Mississippi Valley, there would probably result inci-

dental advantages fully equivalent to the entire cost. For every acre of comparatively barren land at the heads of the streams which must be appropriated for these reservoirs, very many acres of alluvial land, of unsurpassed fertility, on the borders of the larger streams, would be redeemed from the water and made available for tillage. The immense water-power created by these reservoirs, when it all becomes finally utilized, would of itself probably pay for all the cost of the dams. The artificial lakes stocked with fish will yield a much larger food supply than the lands covered by them could be made to produce. However great may be the expenses, the benefits resulting will be immeasurably greater. And if the work is well done, so as to avoid all danger of the breaking down of the dams, imagination can picture no possible evil tendency.

The thorough control of that part of the rainfall which fills the streams is sure to be one of the most important triumphs of practical science. This country is to be the pioneer in the work, or the imitator of others.

With an overflowing treasury, filled without any perceptible burden to the people, we are in a most favorable position to commence this work. Its thorough application to the Ohio River would be easy, and not expensive. Its practicability thus demonstrated, it would ultimately be applied to all the rivers of the country, which would be made to flow in limpid streams at substantially the same level throughout the whole year. The whole of the rainfall would become beneficial, and all apprehension of destructive floods would cease.

Manufacturing interests, having other ends in view, have already substantially accomplished this on some of the New England streams. Dams erected to secure water-power have established reservoirs which practically control the flow of water on streams where the natural drainage is so rapid as to make them peculiarly liable to floods. Here the prime object is the production of water-power—the incidental result, exemption from floods. In the plan proposed the prime object is exemption from floods, the incidental results are improved navigation, an almost measureless production of water-power, and climatic influences, which, while they may be slow in their manifestation, will be steadily increasing and wholly beneficent. Is it not fitting that the people of the United States should be the pioneers in this great work?

One additional suggestion should be made. The arid lands of the West must be flanked, not attacked at the center. Forests must be created upon their borders, not in their center, for there they cannot be made to grow until a humid condition of the soil and the air is first produced. An important beginning has been made in Colorado by diverting the water of the mountain streams into irrigating ditches, and the subjection of large areas to profitable cultivation. From the surface of these ditches the evaporation is rapid and continuous, and substantially

all the water actually used for irrigation is returned to the air by surface evaporation and exhalation from the leaves of cultivated plants.

This system, extended along the whole of the eastern slope of the mountains, will return to the air nearly all thewater diverted from the streams, which from the direction of the prevailing winds will be carried over the plains and fall in showers. The artificial lakes already suggested, discharging the same functions, can be made largely available for irrigating purposes, and there is little doubt that by these means the amount of land on the western border of the plains, put under cultivation, could be steadily and indefinitely increased, so that if conservative measures are adopted on this side also and vigorously prosecuted, the whole of the arid plains would ultimately be redeemed and subjected to profitable tillage.

The moist winds from the Pacific passing over the broad ranges of the Rocky Mountains are deprived of their moisture, and as they fall over the eastern slopes are fitted to absorb rather than precipitate moisture. Moving eastward and mingling with the moist winds from the south and southwest, they increase the capacity of the latter for moisture and diminish the amount of precipitation from them. Let these thirsty winds as they strike the plains become saturated with moisture from artificial lakes, irrigating ditches, cultivated fields, and forests, when they meet these southern winds, instead of preventing, they would facilitate precipitation, and secure rainfall on the plains. It is, as has already been said, a useless work to attempt to plant forests in the arid region. Its arid character must be changed before the forests will grow. The work must be commenced upon the margin and gradually carried into the interior. The Government aid should be directed toward securing, by means of irrigation, the cultivation of as large areas as possible on the western margin of the arid plains and the planting of forests there. We *can* conquer the whole of them and make them available for tillage if all judicious measures are adopted and perseveringly followed.

It is for the people of the United States to determine whether the boundary of this arid region shall be extended indefinitely eastward, or whether the eastern and western boundaries of it shall slowly but steadily approach each other until the arid region disappears.

The magnitude of the work proposed, and the immense amount of water to be controlled, will naturally suggest to many the idea that the scheme is wholly impracticable. But the amount of rainfall over this whole area is now very accurately measured, and it is known that about 40 per cent. of it finds its way into the larger streams. This has been measured in the Ohio, and can be measured in the Mississippi and all its tributaries. The measurement of the flow during the highest floods will show with mathematical exactness just how much must be held back at the times of the greatest danger, to entirely obviate it. This will give us the exact aggregate capacity of all the regulating reservoirs

required. Surveys at the heads of the streams will show where dams at least expense will suffice to hold back the drainage from the largest areas, and will, it is confidently believed, show that the plan is entirely practicable and the cost trifling and insignificant, when compared with the beneficent results which are sure to follow.

THE DISTRIBUTION OF NORTH AMERICAN FOREST TREES.

By Dr. George Vasey.

While we are considering the subject of forestry, and the grave and important question of conserving our great forests from needless waste and destruction, it may not be without interest to take a botanical glance at the composition of these forests and of our woodlands in general. Not only is our country vast and possessed of extensive forest lands, but these forests and arboreal districts are extraordinarily rich in the number and variety of species presented. Outside of the tropical regions probably no part of the globe presents a greater diversity in an equal area.

To show by comparison the richness of our forest flora, we may place in contrast that of Europe, which furnishes little over 100 species of trees, while within the boundaries of our own country we have about 400 species. Estimates of the number of species of trees growing within our limits will, of course, vary with the standard which is assumed as the proper height and size of a tree. The dimensions of trees and shrubs vary considerably in different localities, as influenced by climate, soil, and altitude, so that a tree of good size in some localities may in others be reduced to a shrub. Generally, those plants which are destined to become trees have from the first an erect and firm woody stem, but there are some exceptions to this rule. The flowering Dogwood, *Cornus Florida*, as commonly found in the northern woods, is a straggling bush, but individuals frequently assume an erect trunk and attain the habit and size of a moderately large tree. The *Magnolia glauca*, or White Bay, grows and flowers freely in some portions of Massachusetts, where it attains only the size of a shrub. It, however, steadily increases its size in situations farther south, until in Georgia and Florida it frequently becomes a large tree. In some places, also, the same species appears as a shrub or a large tree, in closely contiguous localities. One of the maples of Oregon is called the Vine Maple, because the stem is at first weak and forming tangled thickets, but some of these stems finally become erect or oblique, and acquire the body and height of pretty large trees.

Generally those plants which are designated as shrubs are not only low in stature, but have the habit of growing in clumps, or developing a great many stems from one main root. In other cases they throw out

numerous stolons and multiply their stems so as frequently to constitute a thicket of bushes.

I think it will be in accordance with general custom to assume that those woody plants which have an erect habit, and ordinarily attain a height of 16 to 20 feet or more, may be counted as trees.

With reference to its vegetation, the territory embraced within our limits may be primarily divided into three regions, but each of these regions includes great variations of climate (which are characterized by peculiar floras), and is therefore subdivided into secondary regions or districts.

1st. The Atlantic Region embraces all that portion of the country from the eastward slope of the Rocky Mountains extending eastward to the Atlantic Ocean.

2d. The Pacific Region embraces California, Oregon, and Washington Territory and the mountain ranges of the western coast.

3d. Lying between these we have an Interior Rocky Mountain Region, embracing the Great Interior Basin with its mountain ranges, the chain of mountains extending through New Mexico and Colorado, and the country southward bordering upon Mexico.

Passing to a more detailed account of the main Regions, we find that in the Atlantic Region we have to make several subdivisions. In the southern portion of Florida we have a very distinctive semi-tropical flora, furnishing about sixty species of trees which appear in no other part of our boundaries, which are mostly identical with existing West Indian species, and are probably descendants of a vegetation which existed at a period when there was land connection between Florida and the West Indies. As very few of these sixty species have any relatives in the other botanical Regions, it will not be necessary here to make a special enumeration of them.

The region lying north of this subtropical district presents a great variety of climate, but it is difficult to draw any close line of separation into sub-regions. Looking at the extreme northern and the extreme southern portions of the territory there is a very strong contrast in the forest productions. Hence we may say that there is a northern and a southern Atlantic division. But the climatic variation of this region is much broken by the Apalachian chain of mountains which provides a pathway by which many of our northern trees penetrate into the States of North Carolina and Georgia. Therefore the number of trees that may be considered strictly northern are few—perhaps less than a dozen of these extend beyond the Arctic circle. These are chiefly the following: Black Spruce (*Picea nigra*), White Spruce (*Picea alba*), Balsam Fir (*Abies balsamea*), Balsam Poplar (*Populus balsamea*), Aspen (*Populus tremuloides*), Canoe Birch (*Betula papyracea*) and Larch (*Larix Americana*). Beside these there are a few which find their northern limits near Hudson's Bay, and seldom pass below the forty-second parallel. These are the Scrub or Banksian Pine (*Pinus Banksiana*), Norway Pine

(*Pinus resinosa*), White Birch (*Betula alba* var. *populifolia*), Yellow Birch (*Betula lutea*), and Arbor Vitæ (*Thuja occidentalis*).

Of the above a very few, namely, the Balsam Poplar, the Aspen, the White Spruce, the Red Cedar, Cottonwood (*Populus monilifera*), the small Mountain Ash (*Pyrus sambucifolia*), the Black Thorn (*Cratayus tomentosa*), the Box Elder (*Negundo aceroides*), and two or three willows, pass across the continent to the northward, so as to be represented on both sides.

But a large number of forest trees of the Atlantic Region range from New York and the Great Lakes southward to the Gulf of Mexico; among these are many Oaks, Hickories, Maples, Ash, several Poplars and Pines. Quite a number of trees seem to be most at home about the middle region of the district extending both northward and southward.

With respect to a large number of the forest trees of the Atlantic Region the line of the thirty-seventh parallel may be taken as the separating line between those which may be called northern and those called southern; those of the one kind seldom passing south of that line, and those of the other kind seldom passing further north.

Among the more characteristic trees of the southern district we may mention five Magnolias, one Prickly Ash (*Xanthoxylum Carolinianum*), one *Holly*, one *Cyrilla*, one *Cliftonia*, one *Sapindus*, two Locusts (*Robinia pseudacacia* and *R. viscosa*), one *Prunus*, one Wild Crab Apple (*Pyrus angustifolia*), five Wild Thorns (*Cratægus*), two *Tupelos*, one Sorrel Tree (*Oxydendrum*), three *Bumelias* (Iron Wood), one Sugar-leaf (*Symplocos*), two *Halesias*, one Ash, one *Forestiera*, one Fringe Tree (*Chionanthus*), one Devil Wood (*Osmanthus*), one Catalpa, one Winged Elm (*Ulmus alata*), one *Planera*, two Hickories, six Oaks, one Swamp Poplar (*Populus heterophylla*), one Cypress (*Taxodium distichum*), and five species of Pines.

There are besides in the South Atlantic and Gulf States a number of trees which only grow in the vicinity of the ocean, and which have their relationship mostly with tropical trees, as, for instance, the Palmetto, the Red Bay (*Persea Caroliniensis*), the Mock Orange (*Prunus Caroliniana*), the Dahoon Holly (*Ilex Dahoon*), the Live Oak (*Quercus virens*), the Mangle (*Rhizophora Mangle*), and the Georgia Bark (*Pinkneya pubens*).

We have also to consider a few trees in the South Atlantic States which are restricted to very narrow limits, and which are probably to be regarded as survivors of an ancient vegetation in gradual process of extinction. These are the Florida Yew (*Taxus Floridana*), and the Florida Cypress (*Torreya taxifolia*), both occupying a narrow strip on the Apalachicola River in Northern Florida; Fraser's Balsam (*Abies Fraseri*), of the mountain peaks of North Carolina; the Southern Hemlock (*Tsuga Caroliniana*), confined to the Southern Alleghanies, and Chittim Wood (*Rhus cotinoides*), growing on the bluffs of the Tennessee

River in Northern Alabama, and again to a limited extent in Arkansas and Texas, to which we should perhaps add a species of Bay (*Gordonia pubescens*), which has not been observed in a wild state for many years and is perhaps already extinct, and a species of Alder (*Alnus maritima*), a small tree growing in Eastern Delaware and Maryland.

Two or three peculiar trees occur in the lower Mississippi Valley which can hardly be classed as belonging to any of the other regions; these are, first, the Osage Orange (*Maclura aurantiaca*), growing in Arkansas, the Indian Territory, Eastern Texas, and Louisiana; and, second, a species of Thorn (*Crataegus berberifolia*), which seems to be confined to portions of Florida and Mississippi.

The great State of Texas seems to unite to some extent the main forest divisions of the country, merging on the east into the Atlantic Region and on the west into that of the Rocky Mountains and Great Basin. In the eastern and southern portions of the State, however, there are a few trees which are either peculiar to the district or are northward extensions of East Mexican trees. Among them we may mention a species of Buckeye (*Ungnadia*), a species of Red-bud (*Cercis reniformis*), the Pistachia, two species of *Sophora*, the Texas Madrona (*Arbutus Texana*), an Iron-wood (*Bumelia cuneata*), the Mexican Persimmon (*Diospyros Texana*), the Thick-leaved Elm (*Ulmus crassifolia*), and a marked variety of Red Cedar.

Passing now to the west we enter the Interior Rocky Mountain Region. And this we find to be divisible into two sections: first, the flora of the mountains and interior basin; and, second, the flora of the arid plateau adjoining the Mexican border, and extending from Western Texas to Southern California. The first district embraces Utah and Nevada, the northern portions of New Mexico and Arizona, with Colorado, Wyoming, and parts of Montana.

The tree vegetation of this district is very limited, confined principally to the mountain ranges. The number of species is very few, principally the following: two species of Maple, one Locust (*Robinia Neo-Mexicana*), one Ash (*Fraxinus anomala*), one Oak (*Quercus undulata* var. *Gambellii*), three Poplars (*Populus angustifolia, P. tremuloides* and *P. balsamifera*), two or three varieties of *Juniperus;* about five species and varieties of Pine (*Pinus flexilis, P. ponderosa, P. edulis, P. monophylla,* and *P. Balfouriana* variety *aristata*); two species of Spruce (*Picea Engelmanni* and *P. pungens*); and one Balsam (*Abies subalpina*).

The southern part of this Interior Region, sometimes called the Texano-Mexican district, extends from Western Texas to Southern California.

The trees of this arid belt number about fifty species, a portion of them being confined to the region of the Lower Colorado, called the Colorado desert, and the remainder dispersed through the dry elevated plateaux, and on the mountains rising from the same, with their slopes and cañons. The more frequent of these trees are, two species of Mesquit and the

Screw-bean (*Prosopis*), several specimens of *Acacia* and *Lucæna*, two species of *Parkinsonia*, one Iron-wood (*Olneya*), one *Dalea*, one *Zizyphus*, the Giant Cactus (*Cereus giganteus*), one species of *Chilopsis*, one Sycamore (*Platanus Wrightii*), about five species of Oak, one Juniper or Arizona Cedar, one Cypress, four species of Pines, the Desert Palm (*Washingtonia filifera*), and two species of tree Yuccas.

We next arrive at the Pacific Region. This, like the other regions, presents a northern and a southern portion. The northern portion, including Washington Territory and Oregon, west of the Cascade Mountains, and also including the northern part of California, is heavily timbered with some of the largest and most magnificent Conifers of the world, such as the Douglas Spruce, the Western Arbor Vitæ (*Thuja gigantea*), the Nootka or Yellow Cedar (*Chamæcyparis Nutkäensis*), *Pinus monticola*, or White Pine, *Pinus Lambertiana*, or Sugar Pine, *Pinus ponderosa*, or Yellow Pine, Oregon Spruce (*Picea Sitchensis*); two species of Hemlock (*Tsuga Mertensiana* and *T. Pattoniana*); one Larch (*Larix occidentalis*), and four superb Balsams (*Abies grandis*, *A. amabilis*, *A. nobilis*, and *A. magnifica*).

The southern portion of the Pacific Region embraces the larger portion of California, and is a much drier district, the plains and Pacific slopes being thinly wooded, but the higher mountain ranges and foothills presenting a great diversity of Conifers, some of them attaining enormous proportions.

In the entire Pacific Region we find but about ninety species of trees, the principal of which are as follows: One species of Buckthorn, two or three species of *Ceanothus*, one Buckeye, three species of Maple, one Box Elder, one Crab Apple, two or three species of *Prunus*, one *Nuttallia*, one Mountain Mahogany (*Cercocarpus*), one Redbud (*Cercis*), two Wild Thorns (*Cratægus*), one Flowering Dogwood (*Cornus Nuttallii*), one Elder-tree (*Sambucus glauca*), one Madrona-tree (*Arbutus Menziesii*), one Manzanita (*Arctostaphylos*), two species of Ash, one Laurel (*Umbellularia*), one Sycamore, one Walnut, one Myrtle (*Myrica*); ten species of Oaks, one Chestnut, one small Birch, three Alders (*Alnus*), three Willows, four Poplars, one California Nutmeg-tree (*Torreya*), one Yew, (*Texas brevifolia*), three Red Cedars (*Juniperus*), seven other trees called Cedars belonging to the genera *Libocedrus*, *Thuja*, and *Cupressus*, the two *Sequoias*, seven species of Firs, five species of Hemlocks and Spruces, two Larches, and fourteen species of Pines.

All the trees of the Pacific Region, except a few Poplars and Willows, are different species from those of the Atlantic Region, quite a number of them indeed belonging to genera which are not else where represented in the United States.

A person accustomed to the varied tree flora of the Atlantic Region will here miss many of the familiar trees of that region. On the Pacific side there are no Magnolias, no Basswoods, no Holly, no Locust, no Sweetgum, no Sourgums, no Persimmons, no Catalpa, no Sassafras, no

Bay-tree, no Elms, no Mulberry, no Hickory, no Beech, no Hornbeam, and only one small Birch. All the Oaks, Pines, &c., are of species different from those of the East.

To recapitulate, we have in Southern Florida 60 peculiar species, in the Atlantic Region about 175 species, in the Interior Region about 70 species, and in the Pacific Region 90 species, making a total of nearly 400 species.

Passing now from this outline of tree distribution, let us briefly review some of the larger orders or families, and note their distribution and range.

The family which is represented by the greatest number of species and is most widely distributed over the country is that of the Oaks, of which we have about 37 species of tree size, besides several shrubby species. Of these 23 species belong to the Atlantic Region, 8 species to the Pacific Region, and 6 species to the Interior and Texano-Mexican districts.

The next largest genus is that of the Pines, of which we have 34 species, distributed as follows: In the Atlantic Region 13 species, in the Pacific Region 14 species, and in the Interior and Mexican border 7 species and several varieties. If we take into account all the Conifers, including the Pines, we find that we have 80 species, the largest portion of which occurs on the western side of the continent.

The next largest family will be that of the Willows and Poplars, of which we have 21 or 22 tree species, a portion of them extending quite across the continent, the others pretty evenly divided between the Atlantic and Pacific Regions.

Of Maples we have about 10 species, 6 of which belong to the Atlantic and four to the Pacific and Interior Regions.

The genus Prunus presents 11 or 12 species, 6 of which are Atlantic, 4 Pacific, and 2 belonging to the Interior Region. The genus Cratægus or Thorns is represented by 11 species, all but 3 of which are confined to the Atlantic Regions.

The Ash family (Fraxinus) gives us 10 species and 2 or 3 varieties, of which 6 species belong to the Atlantic, 2 to the Pacific, and 2 to the southwestern regions.

The genus Carya, embracing the Hickories, furnishes 8 species, all confined to the Atlantic side of the continent.

The remaining genera have a less number of species, very few of them containing more than 5.

ADDRESS OF MR. PHIPPS.

Mr. R. W. PHIPPS, delegate from the Province of Ontario, addressed the Congress substantially as follows:

MR. PRESIDENT: In this address I shall endeavor to give some idea of our position in Ontario with respect to forestry, the amount of land yet remaining in forest, the manner in which Ontario has been and is

being cleared, and the steps which are now being taken by the Ontario Government to prevent the too rapid deforesting of the land.

A hundred years ago Ontario was a forest, a forest of the most valuable description. Many millions of its acres, now largely farming land, were covered with magnificent groves of pine trees, many of them nearly 200 feet in height, and nearly 7 feet through at the base, running up a hundred feet without a branch. Some of them were rendered useful, being converted into lumber when they grew near rivers, or where, perhaps, our first attempts at railways penetrated the forest. But the vast majority, rolled together in log-heaps, fed the flames in many a woodman's clearing.

As it was with the pine so it was with the other trees. Down before the ax went the wide-spreading forests of maple and beech, of hickory and bass-wood—to pass into smoke, to clear the way for the farmer's plow. It must be remembered that this only applies, so far as pine is concerned, to the older settlements, which, however, cleared a good deal of the country. But now, and for many years past, pine and much hard wood have formed a large part of our exports, and are taken much more care of. The right to cut the pine is sold to the lumberman, and the settler may cut it on his lot for use, but not to sell. But if the lumberman has not cut it, the settler may clear the land and burn the wood.

That it was necessary that land should be obtained for agriculture none will deny, but had the cost of the sacrifice then been known, surely much would have been spared. We had in Ontario one large region where much of the forest was heavy black walnut. In all Ontario to-day there is so little left of merchantable black walnut that we are importing that wood from your Indiana, where also, we are told, it is becoming scarce. Some settlers of the early time speak of the difficulty they had in clearing the ground of the walnut trees. They contrived, however, to burn them, and many a square league of land now grows wheat which once grew walnut. In later years they have had an opportunity of judging how profitable their work was when, for one or two of these giants left standing, they have received, as I am credibly informed, as much as a thousand dollars apiece. On many an acre there were fifty such trees, while it is very doubtful if any acre of them all has yielded for agricultural purposes a profit of a thousand dollars from that day to this. In Western Canada, winding through a district where now is scarcely a walnut tree, are two or three miles of an old corduroy road composed of this valuable and once abundant wood. Were its half decayed sticks but sound again they would be worth about a quarter of a million dollars.

The lesson we may learn from the manner in which land has been disposed of to the settler in Ontario, and the results which have followed, undoubtedly make it a question of very grave consideration whether in all future sales of Government lands, before any region is thrown

open for settlement, certain large portions, comprising probably not less than one-third of the whole, should not be reserved permanently as forest lands and preserved perpetually in good and reproductive condition by proper officials appointed by the Government, whose duty it should be to prevent injury, so far as possible, by fire, by cattle, or by unlawful appropriation of timber. It would then be in the power of those who lay out the tracts to leave permanently in timber a great proportion of the mountain, of the swamp, and of the rocky or inferior land, and to throw open for cultivation those portions best fitted for the plow. There is no doubt that such regulations would prove extremely beneficial to the territories settled, and that the cost of Government supervision would be far more than repaid by the sale of the overplus of the timber preserved.

By one means and another, we have been reduced in many parts of Ontario to 10 per cent. of timbered land. Other portions have 20 per cent. and some 40 per cent. left. But the quantity in these is being rapidly reduced. And it is found that through the absence of sheltering forests the winter winds are much more keen than formerly, rendering the keeping and care of cattle much more expensive, while by blowing the protecting snow from the fields, great injury is done to the important crops of winter wheat and clover.

In addition to the grave evils which threaten Ontario, should its stock of firewood be largely destroyed, our supply of wood for many important manufacturing purposes is beginning to run low. Our furniture manufacturers have no more walnut; they find white-ash difficult to obtain; bass-wood, of which we formerly possessed vast amounts, is now so diminished in quantity that the swamp-elm has to be substituted. Our agricultural-implement makers and car-builders, too, already find good oak ash, and rock-elm so hard to obtain that where they can they use iron instead, and in many other woods the present deficiency, as compared with the former abundance, is extremely marked.

If matters were likely to continue in their present position, that is to say, become no worse, there would not be so much occasion for alarm. But this is not to be expected. The railways, the farm-implement makers, the furniture men, the house-builders, the wagon-makers, and the workers in many other industries, are rapidly consuming our stores of wood, and, above all, the farmer in the back townships continues, with ax and torch, to pursue the work of destruction.

It has been proposed in Ontario, as being probably the only way to secure the continuance of any sufficient portion of the interspersing forest, to permit the farmer to obtain on application an exemption from local taxation on such part of his forest as he might declare his intention of continuing in woodland, and from which he will agree to exclude cattle and to cut none but grown timber (15 inches at the base being probably the smallest allowable in most varieties), the exemption to continue while the forest is so preserved. If, however, the owner should

wish at any time to cut down the trees on the reserved portion, or use the ground for pasture, it is suggested that he then become liable for the taxes which have been remitted to him or the bonus allowed.

The Ontario Government have lately passed an act for the encouragement of tree-planting which it is expected will be of great benefit, and which provides that farmers planting trees along the roads or along the dividing lines of farms, some yards apart, will, if the trees are in good order in three years' time, receive 25 cents per tree from the township councils, half of which the Ontario Government will repay to the councils. Many thousand trees have already been planted under this law.

It is plain that the first thing in order to stimulate the community to proper action is to furnish it with the data necessary to produce opinion. Acting upon this idea, Government distributed last year throughout Ontario fifteen thousand copies of a forestry report, which some of you may have seen, which will be followed shortly by another, containing much practical knowledge and experience on the subject. The various counties are to be communicated with in regard to the reservation and protection of portions of forests now in private hands, and means will shortly be taken to investigate the question of the best methods of preservation from fire and continuance in reproductive condition of some of the principal pine forests in the interior.

There is no doubt whatever in the minds of those who have studied this subject, even within the narrow limits which Ontario affords, that the interspersion of a proper amount of forest, though apparently abstracting from the cultivable area of the country, really abstracts nothing, but, on the contrary, adds much. The farmer has found by repeated experience that when the forest is cleared the soil no longer yields its original return. If every farmer would retain, or would plant upon his land, a fair proportion of forest, the benefits to himself and to the country at large would be very great. It is in all such cases our experience in Ontario that cultivation is easier and more profitable, that stock need less food and less shelter, and that winter life in general, and traveling in particular, are far more comfortable than when the country has been reduced to a bare expanse of snowy surface.

Much has been said concerning the influence of forest on rainfall, and it has been admitted by all that, whether forests occasion rain or not, they undoubtedly act as reservoirs of moisture. We know that the clearing of forests dries the land, that surface-creeks by the thousand cease altogether to flow. We know that over vast districts, where wells of 10 feet had been of ample depth, wells of 20, 30, and 40 feet are needed when the forest goes. The retaining of a due proportion of forest greatly aids in giving rain to the fields when rain is most necessary to render them fertile.

I have spoken of the personal interest of the farmer, or other landholder, in forestry. But, passing from the personal to the national view, our populations, pouring from the Old World to the New, or drawing their

first breath upon our shores, have a duty to perform in the matter which cannot be gainsaid. We received America as a land rich in forest, in stream, in fertile soil fit for the future support of countless multitudes. We know what ruin the deprivation of forests has brought upon other lands. We can, in vast floods here, in failing fertility there, already see the premonitions of that ruin in our own. Let us remember that we must not destroy the power of the land to support those who are to come after us. Along the path we tread they will shortly follow. Let us endeavor to stay the tendency to render that path barren and desolate, and strive to leave it as we found it, blossoming with life and fertility, a remembrance to our successors that in our day we endeavored to perform our duty to the land which supported us—a remembrance than which, had we the choice of the wealth of the universe, we could leave them nothing more valuable.

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Walter Mulford
1897

DEPARTMENT OF AGRICULTURE.

MISCELLANEOUS. SPECIAL REPORT No. 10.

A DESCRIPTIVE CATALOGUE

Walter Mulford

OF

MANUFACTURES FROM NATIVE WOODS,

AS SHOWN IN THE EXHIBIT OF THE

U. S. DEPARTMENT OF AGRICULTURE

AT THE

WORLD'S INDUSTRIAL AND COTTON EXPOSITION AT NEW ORLEANS, LA.

BY

CHARLES RICHARDS DODGE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1886.

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LETTERS OF TRANSMITTAL.

DEPARTMENT OF AGRICULTURE,
Washington, D. C., May 14, 1886.

SIR: I have the honor to transmit herewith, for approval and for publication, a report on "Uses of American Woods," based upon materials and information collected by this Department in connection with its exhibit at the World's Industrial and Cotton Centennial Exposition, New Orleans.

The interest in the collection was so manifest and practical that it was deemed advisable to make an investigation by special interrogatories addressed to manufacturers and others relative to the practical uses of woods in their own experience, the results of which are printed below, in the report of Mr. Charles Richards Dodge, who was authorized to conduct the inquiry.

I have the honor to be, very respectfully, your obedient servant,

WILLIAM SAUNDERS,
Representative of the Department of Agriculture at the Exposition, New Orleans.

Hon. NORMAN J. COLMAN,
Commissioner of Agriculture.

BOSTON, MASS., *January* 30, 1886.

SIR: I have the honor to transmit herewith, for publication, a descriptive catalogue of manufactures from native woods, which form a portion of the exhibit of the United States Department of Agriculture at the New Orleans Exposition. Appended to this catalogue will be found some facts and figures relating to wood-manufacturing industries, which, with the opinions of prominent manufacturers regarding the future supply of timber for manufacturing purposes, it is hoped will add something of value to the literature of economic forestry.

I remain, very respectfully,

CHARLES RICHARDS DODGE.

WILLIAM SAUNDERS, Esq.,
Representative of the United States Department of Agriculture at the World's Industrial and Cotton Centennial Exposition, New Orleans.

USES OF AMERICAN WOODS.

INTRODUCTORY.

One of the most interesting collections in that portion of the New Orleans World's Fair known as the Government building was the exhibit of the Department of Agriculture, showing the uses of American woods, which was chiefly made up of manufactured articles in all stages of manufacture representing the wood-working industries of the United States.

At the outset it was thought that such a collection would at least prove a novelty, and perhaps serve to call the attention of many people to the importance of the subject of forest protection who had hitherto given it little thought or care; but as the work progressed and the manufacturers became interested to the extent of preparing and donating many valuable exhibits illustrating prominent industries, it became evident that the collection would prove a useful aid in the study of the forestry question from the economic stand-point.

The future timber supply of the country is a grave question that before many years will demand the urgent consideration of many who now affect to regard it most lightly. In view of the immense annual destruction of valuable timber, through carelessness and ignorance, or worse, indifference, it was thought desirable to obtain some knowledge of the extent and value of our timber resources and the legitimate demand that is made upon them by wood-working industries. To this end a circular letter was sent to many hundreds of manufacturers with a view to learning what woods are most commonly used, chief resources of supply, value of lumber for different uses, wastage, processes of manufacture, opinions as to future supply, &c. Few manufacturers would give the time for a full consideration of the subject in all its economic bearings, but a sufficient number of intelligent and thoughtful answers were received to show that while, on the one hand, our wood manufacturing industries are rapidly using up the best timber growth in the country, on the other, wise legislation and a proper education of the people to the necessity of keeping up the old, or producing new forest growth, will ultimately result in restoring and preserving a balance, especially with regard to the more valuable kinds of hard wood.

Many interesting facts are stated regarding the quality of wood used, or the particular parts of the tree required for the manufacture of certain articles, the various stages of manufacture, extent of special in-

dustries, &c. It is thought that an interesting study may be made of the facts relating to sources of supply, but in the greater number of cases "home supply" is stated as the chief dependence, though sometimes the more valuable woods are brought long distances.

The attempt at economic classification is only provisional. At some future date, when the present collection has been augmented and made more fully complete, a better classification of the uses of woods in manufacture may be suggested. Until that time the present will suffice.

CLASSIFICATION.

I.—In architecture and building.
II.—In transportation.
III.—In the manufacture of implements of industry.
IV.—In articles relating to trade.
V.—In articles for man's physical comfort.
VI.—In articles for education, culture, or recreation.
VII.—In miscellaneous uses not included in the foregoing.

I.—USES OF WOODS IN ARCHITECTURE AND BUILDING.

The building industry is probably the most universal of all human industries which make a demand upon the forest supply, though this demand relates mainly to the softer and less expensive woods. As the term "building" is understood to embrace all framed structures, for habitation or storage, from a fisherman's hut to a five-story hotel or a grain elevator, so are included in this category not only every kind of building that may employ wood in its construction, but stationary structures such as bridges and trestles, and intimately connected with them the raising of derricks and scaffolding, and fencing. The construction of railway and telegraph lines also finds a place in this group, which is illustrated by the following synoptical table of arrangement:

A.—HOUSE BUILDING: Including all kinds of architectural structures. *Frame:* Sills spruce, pine, chestnut, and cypress; posts, plates, braces, joists, studding, &c., white and yellow pine, spruce, hemlock, and other woods. *Outside finish:* Sheathing of pine, spruce, hemlock, or other woods; clap-boards, pine, spruce, and cedar; roofing-boards, same as sheathing; shingles, white and yellow pine, cypress, spruce, oak, &c.; sash and blinds, pine, usually; cornice-brackets, pine, whitewood, &c. *Interior finish:* Laths, spruce, pine (white and yellow), and other woods; moldings, pine, whitewood, and hard wood according to taste; panelling the same; door and window casings, pine and hard woods; doors, mantels, wainscoting, &c., in various woods, though chiefly pine; stair-rails, balusters, newel posts, whitewood, ash, cherry, oak, and other woods. On the Pacific coast redwood is used largely in house building.

B.—BRIDGE AND TRESTLE CONSTRUCTION: Bridges, trestles, derricks, scaffolding, shafts and coffer-dams. Piles of spruce or pine; girders, stringers, beams, planking, &c, spruce, white and yellow pine, and sometimes hard woods; other timber as in house building; staging poles, pine, spruce, &c.

C.—CONSTRUCTION OF RAILWAY AND TELEGRAPH LINES: Ties, switch-frames, signal-boxes, fencing-posts, &c.

A.—HOUSE BUILDING.

Beams, joists, and board lumber. (Not shown.)

Laths and shingles.

Shingles of Michigan white pine, from C. C. Comstock, Grand Rapids; yellow pine, Northrup & Cumming, Wilmington, N. C.; cypress (same firm), hand-made, by negroes in the Dismal Swamp, in sizes as follows: 4 by 18, 5 by 20, 6 by 20, and 7 by 20 inches. Cypress shingles are also exhibited from Gurley & Bro., Norfolk, Va., and A. C. Danner, Mobile, Ala.

All qualities of lumber are used for shingles, cut at all seasons of the year. Spruce and balsam fir are largely used in Vermont. In Pennsylvania, pine and hemlock for shingles are cut at all seasons, though suitable lumber is growing quite scarce in many parts of the State. In North Carolina the pine lumber is cut in fall and winter, both heart and sap being used, though the cypress is usually cut in the summer months. In the Gulf States, cypress is considered one of the most valuable and durable of woods, not only for shingles, but for other portions of buildings where subjected to extreme dampness. It is also used for door-posts, window-frames, gutters, weather-boarding, &c. Outside of house building, its uses are manifold, as it is employed in vessels, rail-cars, cooperage, boxing, and even for nice interior finish. Drawn or hand-made cypress shingles are usually made 18 inches long, in width of from 3 to 8 inches, and put up in four bunches to the 1,000, by measurement, 4 inches in breadth counting as one shingle. In a Vermont shingle-mill the timber goes through the following processes: (1) Logs are bolted up into 18-inch blocks; (2) the bark is removed; (3) the bolts are placed in shingle-machine, which is self-feeding: (4) taken from the saws to the jointer; (5) the shingles are packed in quarter-thousand bundles. The labor represents about 75 per cent. of the total cost.

Sash and blinds.

Only a few examples of this manufacture are shown. Estate of James Turner, Mobile, Ala., donated specimens in yellow pine. William H. Pierson, Wilmington, Del., sent blinds in white pine.

In selecting lumber for this use, as well as for doors, only that portion is taken clearest of sap-wood, knots, and heart.

Doors.

Plain white-pine doors, W. H. Pierson, donor, Wilmington, Del. Exhibits of panels were received as follows: Decorated pine panels, M. P. Mason, Carthage, N. Y.; "curled pine," very handsome examples, Northrup & Cumming, Wilmington, N. C.; panels of pine, walnut, "curly maple," white birch, white ash, and cherry from A. C. Vogler, Salem, N. C.

While every known hard or soft wood is used in manufacturing doors, in one form or another, the principal woods employed are white and yellow pine, and whitewood or poplar, the best of lumber being requisite.

In making an ordinary beveled door the principal machines are, first, the double surfacer or planer, rip and crosscut saws; the material for sash and doors, after being planed, is then ripped or sawed to the required widths, afterwards cross-cut for the length, going next to the

mortise-machine or tenoning-machine, as some parts have to be both mortised and tenoned, while others need but the one operation; next through the molding-machine, which takes the pieces to the required width and at the same time grooves and molds the edge; then put together and placed in the drying-kiln, subject to a temperature of 150 degrees for three or more days, according to the previous state of the material; then ready to be glued and clamped together, after which it is planed, smoothed on both sides either by a planer or hand-plane; then to the sand-papering-machine, and it is ready for sale. In making panel doors, after leaving the saws, the material goes to the panel-raiser, which works a molding around the two sides. There are a number of other machines, such as the band-saw, scroll-saw, boring-machine, shaper, turning-lathe, tenon-machine, &c. A fine sliding or folding door, in hardwood finish, requires different handling, however. The stiles and rails are glued up from common pine strips thoroughly kiln-dried, faced to the thickness of one-half inch less than the intended thickness of the door. They are then covered or lipped with such hard-wood as specified and then represent hard-wood stiles or rails, which are now properly mortised or dovetailed together and the panels filled in with the same or other hard wood in the solid as desired. The moldings are now mitered and glued around the panels on each side of the door, after which everything is nicely cleaned off and sandpapered, and the door is now ready for the polisher. The component parts of a door pass through several machines before they can go together, such as a surfacer worth $800, saws $50, jointer $200, molding machine, $500, mortising or boring machine, either worth about $125, sandpaperer, $550, besides other machines.

Door knobs.

In black ash, black walnut (Ohio and Indiana), white birch, cherry, elm, "curly maple," oak, and apple. Presented by the Union Door-Knob Company, Detroit, Mich. These articles are manufactured from knots or gnarled roots, the wood being purchased by the pound, the wastage amounting to 75 per cent.

Gutters, or eaves-troughs.

Water-conductors in cypress. Also one sample of "anti-freezing and non-bursting eaves-trough," from U. F. Moulton, Burlington, Vt.

Cornice-brackets.

A series in carved or scroll-saw designs, from pine and poplar lumber, presented by Palmer, Fuller & Co., Chicago, Ill.

Flooring, plain.

Example of across-the-grain patent yellow-pine flooring from New Haven Steam Saw-Mill Company; no description accompanying.

Dressed and matched flooring in yellow pine is usually classified as clear flooring, heart on the face side, and free from all defects; first and seconds free from all knots, shakes, and "blue," but may contain all the bright sap; standard flooring 50 per cent. of first and seconds; 50 per cent. of common, and common flooring of sound timber, though it may

have knots or other defects, but not to be badly "blued." In sawing flooring strips three grades are usually made: clear rough strips that shall be all heart, with one side free from defects; first and second strips that are free from knots and shakes, but shall contain all the bright sap; standard, 50 per cent. of first and second and 50 per cent. of common, containing no blue that planer will not remove. In measuring, flooring strips and boards run from 3 to 6 inches wide, and are usually sawed an eighth of an inch thicker than wanted, an inch thickness being in reality one and one-eighth inch.

In the New England States white-pine, spruce, and hemlock lumber is used for different kinds of flooring, and to some extent hard woods, though these are described below.

Flooring, ornamental.

There are several beautiful exhibits of parquet flooring in ornamental designs, the handsomest and largest series coming from Messrs. Baker & Benedict, Chicago, Ill. This series embraces all the hard woods in common use. Two panels were also received from William Hannam & Co., New York City. These are chiefly Indiana white oak, though other hard woods are used from the same State and from Michigan.

There are quite a number of manufactories of "parquetry" mosaic floors, wood carpet, &c., where wood ceilings and wainscoting are also turned out in considerable quantity. A single Eastern firm produces annually near 100,000 feet of $\frac{3}{8}$-inch parquet floor, and nearly half as much of $\frac{7}{8}$-flooring, besides 1,000 feet each of wainscoting and ceilings. The woods used are oak, white ash, black walnut, maple (of different kinds), white birch, sycamore, white holly, and cherry, yellow pine being also employed in each part made. Of course only first-quality lumber is used. It should be mentioned, also, that about 10 to 15 per cent. of imported lumber is used, being chiefly red and white mahogany, rosewood, amaranth, tulip, English oak, and ebony. The labor represents about two-thirds of cost, as each article passes through ten hands and twelve to fifteen machines; besides the wood has to be both air and kiln dried, and finished with shellac or wax, or often highly polished.

In wood mosaic, where the blocks are made to sizes $1\frac{3}{4}$, $1\frac{6}{10}$, $1\frac{1}{12}$, &c., and jointed and grooved to form the mosaic, a greater number of operations are necessary, besides the use of special machines. An alternate jointing and grooving machine turns out twelve blocks per minute. After completion the blocks are assembled in various designs, making sections about 16 inches square, held together by lead. Maple and cherry are frequently ebonized, to avoid use of the foreign wood. Sapwood and wood from young growth are always objectionable, the heart and more solid portions always being used in parqueting.

Moldings and interior finish.

A fine series of machine-made moldings in walnut, white oak, white pine, butternut, white wood, gum, and cherry. From Palmer, Fuller & Co., Chicago, Ill., chiefly from first-growth timber. A second series was received from John J. McNutt's Novelty Wood Works, Boston, Mass. The same woods are employed, the examples being very beautifully polished.

Stair rails and stair balusters.

A large and interesting series of stair rail sections and stair balusters in white ash, cherry, white oak, whitewood, and black walnut are exhibited from Palmer, Fuller & Co., Chicago. A second series was donated by the New York Wood Working Company, 134th street, New York. Balusters in blue ash were sent by Requarth, Hessler & Co., and Purvis Company, New Orleans, La., sent samples in cypress.

Newel posts.

A series in walnut, oak, white ash, and other woods. Palmer, Fuller & Co.

These articles, as well as other manufactures by this firm, are made from lumber obtained in Michigan, Wisconsin, and Indiana chiefly, and largely of first-growth timber.

Pew ends (church interiors).

The same firm contributes a series of six pew ends employing white oak, Michigan birch, Indiana black walnut, ash and black walnut in combination, oak and black walnut, and "calico ash" from Indiana, in combination with cherry.

Weather strips.

In cherry, black walnut, ash, and enameled pine, from S. Roebuck, Fulton street, New York City.

Window screens.

"Dowling's patent adjustable," in walnut, George C. Wetherbee & Co., Detroit, Mich.

B.—Bridge and trestle construction.

This group was not represented. Pine and oak, however, are usually employed in bridge construction, either in combination with iron or alone. Joists and flooring of iron highway bridges are commonly of white oak; used also for ties and guard rails of railroad bridges. Creosoted Southern pine is sometimes used for flooring.

A large bridge-building company states that Michigan white pine, and white pine grown in Pennsylvania are used in Howe truss bridges. The white oak is usually obtained in the locality where the bridge is constructed; can be cut at any season, although the best pine is cut in the winter season. Bridge lumber is in all sizes and lengths, from 6 inches square to 10 by 24 inches, and from 14 to 50 feet long.

It is estimated that there are some sixty bridge-building companies or firms in the United States at the present time, employing a large number of men, and with an invested capital of $8,000,000 to $12,000,000. It is difficult to get at the average of prices for bridge lumber. As near as we can estimate, white oak ranges from $12 to $25 per M according to locality; white pine, varying according to length, ranges from $16 to $24.

C.—Construction of railway and telegraph lines.

Railroad ties.

These were not represented, save by one example of creosoted yellow-pine tie, from Northrup & Cumming, Wilmington, N. C.

Professor Sargent states that the railroads of the United States, old and new, consume every year not far from 60,000,000 ties, representing

a destruction of 30,000,000 vigorous, healthy young trees; that is, upon the supposition that two ties are cut from a tree. This shows a drain upon the forest wealth of the country "that should cause grave apprehensions for the future, especially in view of the fact that in every part of the country there are now growing fewer seedling trees of species valuable for railway ties than when the trees now cut for this purpose first started."

The value of railroad ties put down by completed roads in 1880, not counting some 10,000 miles of road, amounted to nearly $10,000,000. Ties are made chiefly from oak, hemlock, and red elm.

Fence posts. (See following.)

Telegraph poles. (Not represented.)

These are cut from white cedar, red cedar, white ash, and oak, and sometimes from other woods. It is claimed that Chicago furnishes one-third of all the telegraph poles used in the United States, one-ninth of all the railroad ties, and 5 per cent. of the posts, supplying railroad and telegraph lines from New York State to Utah, southwest as far as Arizona, besides sending some poles to Mexico. Telegraph poles and posts are chiefly made from white cedar. No pine is used for poles. Beside railway uses, posts are used for fencing and street paving. Average duration of white-cedar posts and poles, eight to ten years. Red cedar, white oak, and burr oak, last longest, in the order named; the latter will probably last twelve years or more. Very little red cedar is used, and it is not stated how long it will last. Much of the white cedar comes from Wisconsin and Michigan, and the hemlock from Canada.

Poles are usually cut in winter, peeled in the spring, and finished at stump; posts and hewn ties also finished at the stump.

A large Chicago dealer in these railroad timber supplies states that there is cedar enough in the country to last one hundred years, but it will be very expensive twenty-five years from now, and that all railroads building west of the Mississippi River should have been forced to set aside for tree culture two sections of land for each 10 miles of railroad built. They should have divided these sections into thirty-two 40-acre pieces, and planted 40 acres of timber to each 10 miles of road each year, taking thirty-two years to get it all in. By the end of twenty-five to thirty years they would have plenty of ties, and at less than half they have to pay for them now in Western Iowa and Minnesota, Kansas, Texas, Nebraska, and Dakota.

It could have been done then at $2.50 per acre. Now, of course, it would cost more; but even now it is the only way out for the railroads, and would also do more than any one thing to put forests in the treeless States, which they want so much.

Cross-arms.

Cross-arms for telegraph posts in white cedar or juniper, from the Dismal Swamp, Va. Presented by the New York Cedarware Company, 82 Wall street, New York.

Telephone.

Wood-work of fixture, signal buttons for the electric bells, &c. Western Electrical Company, Chicago, Ill.

II.—USES OF WOODS IN TRANSPORTATION.

While this is not so large a division of industries as the preceding, it nevertheless forms a most important group, consuming millions of feet annually of the choicest hard-wood timber that can be obtained, and much of it timber which cannot be replaced. It may be stated in illustration of the importance of the three industries, ship, car, and carriage and wagon building, that the invested capital in 1880 amounted to nearly eighty millions of dollars, and that the annual product, in round numbers, amounted to almost double these figures. The different uses of woods in the construction of, or in connection with, vessels or vehicles for moving mankind or the property of man from place to place are grouped as follows:

A.—SHIP AND BOAT BUILDING: Illustrated by a three-masted ship, as constructed in a New England ship-yard. *Hull:* Keel, white oak, though rock maple, yellow birch, or southern black gum are also employed; keelson, yellow pine, sometimes hard woods; ribs or frame, oak, chestnut, or hackmatack; stem and stern post, white oak; apron (inside of stem), live oak; planking (exterior of frame), white oak or yellow pine; ceiling (interior of frame), yellow pine; transoms and knees, hackmatack and white or red oak—formerly live oak; deck frame, yellow pine; upper deck, white pine; lower deck, yellow pine; rails and all finishing timber, white oak; treenails, with which timbers are doweled together, yellow locust; house or cabin, white pine, whitewood, or fancy hard woods (interiors) according to taste. *Above deck:* Bowsprit and masts, white pine; spars, spruce; steering apparatus—wheel, various hard woods; rudder, oak; rigging parts in wood—tackle blocks, white ash or gum; mast-hoops, oak; dead-eyes, &c., lignum-vitæ; belaying pins, oak or hickory; fids, hickory.

In a "hard-wood frame," as built on the Maine coast, hackmatack is used at the top, on account of its durability, maple, birch, beech, and oak being used below. Smaller vessels are sometimes built throughout of spruce, with some oak, though they remain *prime* only about four years. In small boats and canoes, with their necessary oars, paddles, masts, &c., white and red oak, red elm, pine, white cedar, brown ash, spruce, cherry, walnut, and bass-wood are used.

B.—CAR BUILDING, in which is included railway and street cars, elevator cars, and hoists. Illustrated by a passenger coach as constructed by the New York, New Haven and Hartford Railroad Company. *Bottom:* Side sills, intermediate sills or stringers in southern or yellow pine; end sills of white oak. *Frame:* Door and corner posts, ash, sometimes whitewood; side posts, ash, that of second growth preferred; plates, ash or pine; window sills, ash; car lines or rafters, white oak and ash; dome plate and dome posts, ash. *Exterior:* Paneling, letter-

board, and moldings, whitewood (as this wood takes paint better, and gives a nicer finish). *Interior:* Doors, mahogany; window frames, cherry; blinds (when used), slats, bass; frame, cherry; seat frames, wood parts, oak; floors in ash, &c.; interior paneling, various fancy native and foreign woods, according to taste; ceilings, usually oak or maple. *Trucks:* Wheel piece and end piece of truck frame, truck bolster, spring beam, spring plank, safety beam, brake beam, brake block, &c., of white oak. There are many other lesser beams and parts connected with platform, or used in frame, or that occur in freight or other cars, but the same woods, relatively, are used, and to name them is unnecessary.

C.—CARRIAGE AND WAGON BUILDING: Includes the building of omnibuses, wagons, coaches, carriages, carts, barrows, and trucks. Illustrated by a carriage as built in New Haven. *Gear:* Axle-bed, head block, perch, side bars, futchells, puncheon, draw bar, &c., light or perch work of hickory, heavy parts of ash. *Draught:* Shafts, pole, and swingletrees, hickory. *Wheels:* Hubs, elm (generally), black birch, locust, oak, and black gum (the latter Middle and Southern States); spokes, hickory or oak; rims, hickory oak or ash. *Body:* Rocker, pillars, bars, top rails, and rafters, ash; paneling, whitewood; bows, usually ash.

D.—HARNESS, WOOD-WORK, &C.: Saddle-trees, oak, poplar, ash, beech, gum, elm, hickory; hames, oak, chiefly, also white ash, white or soft maple, rock elm, and hickory; wood stirrups, white ash, black ash, and hackberry; martingale rings, rock maple; whip-stocks, hickory, holly, and Osage orange.

A.—SHIP AND BOAT BUILDING.

No examples of ship-building timber were shown in the collection of woods exhibited.

Frame timbers.

These are from the best quality, winter-cut oak, usually received in the log, and estimated by the ton of 480 cubic feet. In a vessel of 1,500 tons register, about 600 tons of oak are required in the construction, 400 M yellow pine, and 50 M white pine and decking. Chestnut, birch, maple, beech, and hackmatack frame timbers are also used, the latter coming next to oak in demand.

Knees (chiefly hackmatack or juniper).

They are dug from the roots of the trees, the trunk forming the stock of the knee and the root the arm. They are roughly hewn in the woods, then dressed for market on a rotary planer, the sides only being taken off. Two-thirds of the cost is labor and transportation. Of course one tree furnishes but a single knee, but it is claimed that hackmatack is of rapid growth, twelve years sufficing to make a tree large enough to produce a 6-inch knee. The New England ship-builders use Maine timber chiefly, cut on the Penobscot River and its tributaries, though some comes from Canada. One correspondent estimates that 40,000 knees are annually shipped at Bangor. Knees are rated by their size, a 4-inch knee costing 35 cents; 5-inch, 65 cents; 6-inch, 80 cents; 7-inch, $1.50; 8-inch, $2.50; 9-inch, $3.50; 10-inch, $5; 11-inch, $6; and 12-inch, $7. It is further stated that there has been a decrease of about 15 per cent. in cost in late years, owing to increasing use of iron in ship-building, and increased facilities for railroad transportation.

Masts and spars (pine and spruce).

Spruce spars are generally cut from Maine timber, though large spruce sticks for heavy spars are imported from Canada. Mast timber for large vessels comes from the Middle States, Pennsylvania, and Maryland; yellow-pine lumber from Georgia. While mast and spar timber is best when cut in the winter, replies show that it is cut at all seasons of the year. A Maine firm, dealing in masts and spars, says, "We seldom send finished sticks out of the States, but frequently send deck-loads of rough or rough-dressed stock to South America upon orders."

Small boats.

Fishing dories and pleasure boats are constructed from oak, pine, cedar, and various hard woods in combination, according to taste of buyers. A Newburyport builder of fishing dories uses second-growth white pine and old-growth red or yellow oak. The very best quality is used, cut in the winter and allowed to season through the summer "Best cuts for the sides are employed, heart and sap alike; cuts for bottoms, 13 to 20 feet long, of second growth, neither old growth nor sapling."

Whale-boats employ in construction white and yellow oak, spruce, white pine, white cedar, birch, and maple.

Canoes.

J. H. Rushton, Canton, N. Y., donates a canoe, the Sairy Gamp, together with parts of canoes and similar pleasure craft, in white and red oak, red elm, pine, white cedar, brown ash, spruce, cherry, black walnut, hackmatack, and bass-wood.

Hunt & Morrison, Oldtown, Me., also contributed a birch-bark canoe, frame of cedar, covered with bark of silver birch.

The labor is 50 per cent. of the cost of a sailing canoe. The oak employed in its construction is got out of the plank by circular saw, finished with planer. Hackmatack knees reduced to form with hand-saw, chisel, and mallet, to make sterns and keelson. Siding, barrel resawing machine and planer, rest hand-work; braces and deck-timbers reduced to shape by barrel-saw, finished by hand; deck-work in mahogany all hand-work, as the material is procured proper thickness. All wood is air-seasoned only, from one to three years.

The following description of the building of the birch-bark canoe is appended:

With his materials at hand the canoe-maker first prepares a suitable place for the operation. This is usually a spot having a clayey bed, capable of being flattened into a hard, smooth bottom, sloping gradually from the center each way until, in a distance of half the required length of the canoe, it shows a fall of 4 inches. Sometimes, however, boards are used instead of the clayey bed, sloping them from the center in the same manner. The builder now rifts from a cedar log two rails, 1½ inches square and 15 to 20 feet long, according to the desired length of the canoe. These are fastened securely at the ends and fitted with cross-pieces or thwarts, five in number, which serve the double purpose of strengthening and supporting the canoe and supplying seats for the occupants. The frame is then placed on the ground previously prepared, the center touching the center of the bed and the extremities resting on pegs driven into the ground and rising to a height of 4 inches.

Stakes are then made 1½ to 2 inches in diameter and 3½ feet long, and driven into

the ground to a depth of 6 inches at the extremities of all the thwarts, and at intervals between them of 14 to 18 inches. These stakes are then pulled up, care being taken that the holes be left clean. The frame is removed, and the long strip of birch bark (usually in one piece) is laid down, the frame put into its old position again, but over the bark, and then weighted with rocks to keep the bark firmly in place. The bark is then cut at intervals, about six times on each side up to the frame, the sides of the bark brought up to the perpendicular and held in position by two more cedar rails of the length of the canoe and 2 inches wide, which in turn are supported by the stakes now replaced in the old holes. The bark, which previously to bending had been slightly heated at the sides with water to make it pliable, is now allowed to cool, the rocks are removed, and the frame raised up to a height of about 7½ inches at the center, and two pegs of this length are placed under the ends of the center thwarts, which are weighted with rocks, as before. Two more pegs, 2 inches higher than the others, are placed under each of the two next thwarts to the right and left of the center, while the two extreme thwarts are raised to the height of 18 or 19 inches, and held in place by similar pegs. The ends of the bark are now brought up, trimmed in proper shape, and firmly sewed. The sides are trimmed down to the frame, and either sewed or nailed to it. A good coating of tar is then spread on the inside, along the entire length of the bark, which is often supplemented by canvas or strong sheeting. Strips of cedar splints are then got out and placed lengthwise in the bottom of the canoe, forming a complete lining. Ribs of the same material, thick enough to make the canoe firm and steady, are studded in, and a narrow cedar rail is run along the whole length of the top of the frame. The canoe then receives a little stuffing of shavings for a foot or more at each end, to add firmness there and resist pressure, and the shavings hidden from sight by a light cedar partition.

More or less scraping and carving follow, and then the canoe is complete, save for a coating of tar on the outside, where the necessary cuttings had made a few breaks. If more finish and completeness is desired shellac or varnish is applied, and if the maker has succeeded in his work, you will have a light, graceful craft, easy to propel, capable of carrying a heavy load, and though a trifle coy and skittish at first, to the unaccustomed, it soon becomes tractable and a source of great satisfaction to the possessor.

Regarding the little canoe, the Sairy Gamp, Mr. Rushton makes the following statements:

It was built for Mr. George W. Sears (better known as "Nessmak"), of Wellsborough, Pa. Mr. Sears is over sixty years old, weighs about one 100 pounds, and is a veteran backwoodsman and a very pleasant writer on woodcraft. He took this canoe—9 feet long, 24 inches beam, 8 inches deep amidship, weighing but 10½ pounds—at Lowville, N. Y.; cruised to Paul Smith's, 118 miles; back by another route, 143 miles. The boat was tight and perfect, and weighed but 10 pounds and 11 ounces. It was then sent to Forest and Stream office, where it remained a year, being used upon occasion to hold water, in which model or miniature yachts were floated; a severe test, by the way, as it might stand weeks in a warm room empty, then be filled with water for a few hours, &c.

Oars, paddles, &c.

Examples of oar-stock in white ash, with oars in various stages of manufacture. Hinckley Brothers & Co., Boston, Mass.

Oars, paddles, and oar-stock in spruce and white ash, J. H. Rushton, Canton, N. Y.

In the manufacture of oars the logs are first cut by a large circular saw; then molded by patterns, and sawed again by a small saw into rafters; then turned out by a lathe into unfinished, the finishing (planing, &c.) being accomplished by hand.

There are probably a score of factories in the United States manu-

facturing this class of goods. A Bangor (Maine) firm consumes eighty to one hundred thousand feet of lumber annually in this industry, the very best quality of ash and spruce being required. Average cost of lumber, in the log, $15 to $18 per thousand feet.

Tackle-blocks.

Large ship block in white ash sent by Bagnall & Loud, Boston, Mass. Another collection of six blocks in various styles and sizes was received from the Detroit Block Works, Detroit, Mich.

It is estimated there are something like twenty establishments in this country engaged in the manufacture of this kind of merchandise, employing about 300 men and a capital of $375,000. Twelve manufactories have lately formed an association representing seven-eighths of all the blocks made in the country. The "shell" of a tackle-block, while seeming to be fashioned from one piece or solid block of wood, is in reality composed of a number of pieces sawed into proper lengths for sides and ends, and clamped, bolted, or riveted together. The different processes are thus described:

Saw lumber into right lengths and widths, then bore rivet-holes by machine, then pass to shaving-machine and make the curve on outside pieces, then cut slot, if for iron strap; then put together with end pieces, and rivet them together; then saw into shape on band-saw; then pass to scoring-machine, and take out ends; then to sand-belt machine, and finish. Afterwards fit iron straps, if intended for inside iron straps; then drill through wood and iron for pin-hole; then fit sheaves, put in stud-pin, and fit a cap of zinc overhead, stamp each block with letter so as to determine whether it is iron bushed, patent roller bushed, or metalline bushed; then clean up shell, and oil and shellac wood, and you have the complete block ready for the market. The iron straps, if intended for marine use, are galvanized. If for land use are blacked over, using asphaltum.

First quality of second-growth ash is generally used, cut in the winter season. Wood from New Hampshire, New York, Michigan, Indiana, Ohio, Kentucky, Tennessee, North Carolina, and Mississippi. The Southern ash is considered superior to that grown in the Northern States for this use, and is more plentiful. Lumber varies in price from $25 to $50 per 1,000 feet, first quality Western ash costing in Boston $38; purchased in plank 8 to 16 inches in width and 1¼ to 2½ inches thick. Lignum-vitæ wood is used for the sheaves (or wheels), one New England firm consuming 300 tons annually for this purpose. There is a very large export trade of this class of merchandise, American "blocks" being sent to England, South America, East and West India Islands, and even to Africa and Australia.

Rudder.

One finely finished ash rudder, from S. F. Bannar, Wilmington, Del.

Sailmaker's fids.

One set from W. W. Gillette, Bozrahville, Conn.

Fids as used by shipriggers and sailmakers are of two kinds, viz, hand-fids and set or cringle fids. The former are about 18 inches long

and about 2 inches diameter at the large end, which is rounded to fit the palm of the hand. The other end is brought to a point. They are made of best second-growth hickory, or other hard, close-grained wood, and are used for opening the strands of rope in splicing, also for setting grommets in sails, &c. The set or cringle fids are of similar shape, except that the large end is cut square off to stand upon the floor. They are, however, much larger than the hand-fids, being from 30 to 40 inches or more in length and from 4 to 8 inches in diameter. They are used for setting thimbles in rope, &c.

B.—Car building.

Beams.

Brake beam, in Connecticut white oak. Presented by New York, New Haven and Hartford Railroad Company, from the company's shops at New Haven.

Panels.

One complete smoking-car panel, in section from floor to ceiling, white ash and cherry. Ceiling panels in maple and white oak, beautifully finished; cherry window-frame. Presented by the New York, New Haven and Hartford Railroad Company, from shops at New Haven. Finely finished panels in curled Southern pine, from North Carolina Car Company, Raleigh.

The following are the principal woods used in car construction, with the States from which the larger portion of the lumber supply is drawn:

Oak: Michigan, Ohio, Pennsylvania, Virginia, Connecticut.
Ash: New York, Pennsylvania, Ohio, Michigan, Indiana.
Poplar (whitewood): Ohio, Indiana, Michigan, Kentucky, Tennessee.
Bass (linden): New York, Pennsylvania.
Cherry: New York, Pennsylvania, Ohio, Indiana.
Maple: Ohio, Michigan, Indiana.
White pine: Michigan.
Yellow pine: Southern States.

Only prime quality is used, chiefly winter cut, the prices averaging: Oak, $40 to $50 per thousand; ash, $35 to $45; poplar, $30 to $45; white pine, $20; yellow pine, $40. The various processes for preparing lumber for use cover a number of years. A large manufactory in New York City illustrates this as follows:

Order for lumber in the fall season; cutting logs in winter; sawing and delivering lumber the following year; yarding lumber for air-drying two to three years; cutting to shape and approximate sizes; drying in warm rooms (about 125° Fahr.); dressing lumber to exact forms and sizes; storehoused for use as needed.

C.—Carriage and wagon building.

Running parts.

One carriage part (running part) of landau or coach, showing the progress of manufacture from the rough lumber to the finished part, and ready for the smith, W. G. Shepard & Co., New Haven, Conn.

Hickory side bars, white ash sulky axle beds, S. N. Brown & Co., Dayton, Ohio.

Hickory spring bars for light wagons, William C. Cramer, Philadelphia, Pa.

Brake block, in white oak, G. Lengert & Sons, Philadelphia, Pa.

The running parts of carriages and similar vehicles are chiefly bent work, best second-growth white ash or hickory being used. The pieces,

after having been sawed (sometimes planed) to the right dimensions, are steamed from one to ten hours, according to size and character of timber; they are then bent upon forms, under pressure, where they remain as long as they were steaming. After having been given their approximate shape, as for a corner post, they are faced on the planer, finished, and are then ready to be packed for shipment to the carriage manufacturer. Mr. Shepard, of New Haven, who donated a full series of these manufactures, has succeeded in bending 4 by 2 inch white ash into links in perfect circles, 12 to 15 inches in diameter, the ends fitting to a nicety, and the whole forming a short chain. He also succeeded in completely rolling up upon itself a stick of heavy white ash 4 by 2 inches and 12 feet long, forming what he has called in his catalogue of donations an "evolute."

Very best hickory for the purpose of carriage bent work is worth about $100 per thousand feet, and ash three-fifths this figure. Hickory should not be used for carriage bodies, unless it has been cut one and a half years, and even two years is better. The Connecticut carriage-makers are still able to get choice hickory grown within the borders of the State, though the supply is rapidly diminishing, with a prospect of failure altogether at no remote period.

Poles and shafts.

Coach and buggy poles in hickory, buggy shafts in hickory and white ash, S. N. Brown & Co., Dayton, Ohio. Hickory swingle-trees, G. Lengert & Sons. White-oak swingle-tree, H. Rademaker, Grand Rapids, Mich. Finished coupé shafts in hickory, W. G. Shepard & Co., New Haven, Conn.

Poles and shafts are usually bent to form, in the same manner as the preceding, the same woods being used.

Body parts.

Coach panel in whitewood, H. Killam & Co., New Haven. This sample is 34 inches in width, though they are sometimes 36 inches, or larger. Section of wagon bed in whitewood and basswood, from Pennsylvania, G. Langert & Sons, Philadelphia.

White poplar or whitewood is the principal wood used in all kinds of carriage panel work on account of its peculiar fitness, as well as great width; basswood panel stock is also employed to some extent. This is worked out of the log (circular cut) in long sheets, the process being patented. The Ranger Bros., East Wilton, Me., thus describe the process: "First, the logs are cut up into 3 and 4 feet lengths or bolts, put into large box, and steamed until they are in the proper state to be cut into the desired boards or panels; then they are first put into the cutting-machine, weighing 3 tons. The knife is 52 inches long, 1 foot wide, seven-eighths of an inch thick. The log revolves until it is cut up to within 7 inches, and this is left, being the heart. The board runs off on a table, sometimes in one whole sheet, 75 feet wide, perfectly whole and smooth, and even in thickness. Two thousand feet of logs are cut into boards of this description.

In three or four hours after the cutting the sheets are again cut into

different sizes for panels, and put into piles with 2-inch sticks between each board, and allowed to remain until perfectly dry. The bass-wood lumber is obtained in Maine. Other woods, as yellow birch, brown ash, and poplar are sometimes cut in this manner for veneering, sheathing, &c., and for paneling in houses, where it is desired to show natural woods. The various uses are stated as follows: Sleigh and carriage panels, dashers, carriage-top sheathing (one-eighth and one-fourth inch thickness), cloth-boards, drawer-bottoms, picture-frame and mirror backing, and house finish, as above.

Seats.

Sulky seat in white ash, S. N. Brown & Co., Dayton, Ohio. One T-cart seat rail, W. G. Shepard & Co., New Haven, Conn.

Bows.

Buggy and socket bows in ash, S. N. Brown & Co. The same, Donges & Co., Hamilton, Ohio.

Hubs.

Elm hubs and wood in the rough, from the New Haven Wheel Company, New Haven, Conn. The same, S. N. Brown & Co., Dayton, Ohio. The same, John Buckley Spoke and Wheel Company. Hubs, John Donges & Co., Hamilton, Ohio, and George B. Keim, Philadelphia. Gum coach hubs, Howard M. Du Bois.

Spokes.

Heavy spokes in oak and hickory, woods from Atlantic States, New York to North Carolina, and from Ohio and Pennsylvania; John Buckley, Spoke and Wheel Company, Philadelphia, Pa. Carriage and general spoke work in oak and hickory from second growth timber. New Haven Wheel Company. Spokes from Pennsylvania hickory (second growth), G. Wenzler, Philadelphia, Pa. White oak and hickory spokes, from C. C. Andrews, Galion, Ohio; S. N. Brown & Co., Dayton, Ohio; John Donges & Co., Hamilton, Ohio, and Burlington (Iowa) Spoke Company. Heavy oak spokes, P. Roscoe, Windsor, N. C.

Rims or felloes.

Oak and hickory rims in various stages of manufacture from rough timber to finished work, from New Haven Wheel Company. Rims in oak and hickory from S. N. Brown & Co., Donges & Co., and H. M. Du Bois.

Wheels (completed).

Light carriage wheel (American wheel), from the New Haven Wheel Company, New Haven, Conn. Pair of wheels, C. C. Anderson, Galion, Ohio. Patent wheel, H. Rademaker, Grand Rapids, Mich.

The following interesting description of the various processes in the manufacture of a carriage wheel is given by Mr. E. E. Bradley, secretary of the New Haven Wheel Company:

The processes the different parts of a wheel passes through are many and varied, and though they do not pass through them all at the time the wheel is made, it will perhaps be well to state the successive stages from the tree to the finished article. Ordinary styles of wheels are made up of three main parts; as hubs, spokes, and rims, and as each part passes through dissimilar processes, I will describe each in order:

Hubs.—Tough young elm trees of about 8 inches diameter through the butt, and usually of the variety known as white or rock elm, are cut down in the fall, after the

sap has been expended in perfecting the tree for the season. About 8 feet of the butt is then cut off and taken to the wheel factory. There it is cut up into lengths of about 9 inches—an 8-foot butt usually making about ten blocks. The bark is then roughed off from these pieces, a hole bored from end to end through the heart, then put into a steam box and steamed for two hours. After being taken out and dried off some, the ends are painted or dipped in a preparation to exclude the air, and so prevent checking, when they are laid away in a dark room to pass the trying part of the seasoning process, viz, the first six or eight months, during which they will stand but very little air or light without checking or splitting, later they will stand a good deal of both; at the end of one year, more or less, they are taken back into the factory, the center hole reamed out larger, outside surface turned off to size, ends cut off to length, repainted and put in drying-rooms, thoroughly dried for two or three weeks, then taken to turning rooms, put in lathes and turned to any desired size and style, oiled over, and in a day or two taken to mortising-machines and mortised for proper sized spoke, after which they go to chipping-machines, where mortises are chipped out so shoulders of spokes will fit down snugly into surface of hub. The hubs are now ready for spokes to be driven into them.

Spokes.—Tough young hickory or oak trees are selected and cut down in the fall of the year, the butts sawed off at spoke lengths, say 26 to 30 inches, a 9-foot-length butt making about four spoke-lengths. These lengths are then split lengthwise with the grain into right sizes for the average run of spokes, the bark is taken off, and they are then taken to the wheel factory, piled up under cover where they can have plenty of ventilation for six or eight months, then the ends are sawed off to get to solid wood (for ends will check some in seasoning), also to bring the pieces to required length for turning; then they are turned into the shape and size of spoke desired; after this they are piled in racks for a few weeks, then taken to the different machines and rough-belted, throated, faced, tapered, fine-belted, and tenoned at lower or hub end, then placed in a warm room and kept a few days so that no dampness is left in them, then taken to a sizing-machine where tenons are all tested for size to see that all are alike. Scratch-cutters are used on the tenons to give them a rough glue-holding surface, the ends of tenons are then clampered a little so they will readily enter the hub-mortise. The spoke is now ready to go to its appropriate hub.

Rims.—Tough, good-sized hickory or oak trees that are straight and free as may be from knots, winds, and other imperfections, are selected and cut down in autumn, then 7 to 9 feet of lower part of the butt is cut off and shipped to the saw-mill, where it is sawed from end to end into plank of desired thicknesses—say 1¼ inch to 2¼ inch. These planks are then delivered to the wheel factory and piled up, small sticks being placed near each end to keep the planks apart and permit free circulation of air, thereby preventing staining and assisting seasoning. After a few months each plank is sawed lengthwise into strips, which later are cut off so as to be of right lengths to make rims of heights desired for the wheels, then run through planing-machines, put into steam-boxes, steamed until they will readily bend into half circles without breaking, and then put on bending-machine and bent into form. After remaining on the forms a few hours to set they are raked up in bundles of usually a set (eight pieces) each, and put into drying-rooms for a few weeks until seasoned enough for use; the bundles are then broken open and each rim run through planers to square it up and bring width to right size for the tire, the ends are cut off, and each one marked on to its appropriate wheel; ends are bored for dowels, and holes (mortises) bored at right distances for the outer (rim) tenons of spokes; each rim is then rounded and belted, and is then ready for its place on the wheel.

The wheel.—A set of the parts (hubs, spokes, and rims) described above is now brought together. A hub is placed in a spoke-driving horse; the gauge is set so as to give the wheel the disk required. The spokes are placed with lower ends resting on a warm steam-chest; a steam glue-kettle with glue heated to proper pitch

and glue-stick in it stands close at hand; so also does the man who is to drive the spokes, with his long-handled mallet and short-handled chisel. First he takes up a spoke and looks it over to see if it is straight and perfect for the work; then he puts glue on its tenon and into the hub mortise with his glue-stick; with his long-handled mallet he now drives the spoke-tenon into the hub-mortise until the shoulder is close to the surface of the hub; then with the chisel cuts into the hub around the spoke shoulders, so that the latter will settle well into the hub surface, and finally drives the spoke home. After the spokes are all driven and glued spots cleaned off, the wheel is taken to a spoke cut-off machine and the spokes cut down to proper length for height of wheel ordered; then to a tenoning-machine, which cuts tenons on the upper ends of the spokes to fit holes bored in the rims; then to a "rimming-horse," where the rims are driven on and dowels put into their ends to hold them evenly together while being finished up by hand and smoothed off; then the wheel is taken to a treading-machine and the tread planed off smoothly for the tire. The quality-mark and maker's name are then stamped on front ends of hubs, and the wheel is ready for the market.

The processes the parts go through from beginning to end average about sixteen each, and in putting together to form the wheel about twelve more, making a total of some sixty operations to produce a finished wheel, ready for ironing and painting. Nearly everything is done by machinery, there being about one hundred and sixty machines that run by steam-power, besides some that do not. Labor represents about 60 per cent. and rough material about 40 per cent. of total cost of the products. The lumber is received mainly from the sea-coast States, beginning with Connecticut and ending with North Carolina for hickory. For white oak and elm Connecticut and Massachusetts chiefly. All timber is cut, as a rule, in the fall and early winter, when it is far more solid and perfect than at any other season.

Mr. Bradley further says:

While there are millions of acres of forest (first growth) hickory and oak, the supply of second growth is limited, and costs at present about three times as much as forest. The latter is used largely in cheap wheels, and wheel parts, but will not satisfy the requirements of good work. For the latter, second growth, which is far tougher and more durable, only will answer, and therefore that should be husbanded. A substitute for hickory hoop-poles (which, besides being used for hooping casks, &c., here, are also exported, I am informed) should be found as soon as possible. The cutting of "baby" hickory trees or saplings, from four to ten years old, should be discouraged, as the second-growth hickory supply is liable to become a serious question in the near future, unless systematic efforts are soon made to prevent waste of what we now have, and to encourage its further propagation and cultivation.

Ohio manufacturers draw the bulk of their supplies from their own or contiguous States; spoke-timber comes from Ohio and Indiana; hub-timber, Ohio, Pennsylvania, and New York; rims, Ohio, Indiana, and Kentucky. Some hubs are manufactured from gum-wood, or sometimes from oak, though elm is most commonly employed.

Miscellaneous.

An "evolute" or piece of white ash timber, 2 by 4 inches, rolled into a complete spiral, as an example of difficult bending, W. G. Shepard & Co., New Haven, Conn.

One sample of white-ash bent work, broken to show interweaving of wood fibers, the result of wood bending by end pressure, W. G. Shepard & Co., New Haven.

Trucks and skids.

Store and railroad trucks, in rock elm and hickory grown in Michigan. Presented by the United States Truck Company, of Detroit, Mich. First-growth woods only are used.

D.—HARNESS WOOD-WORK.

Saddle-trees.

A number of samples were received from Miller & Buchanan, Front street, Cincinnati, Ohio.

These are manufactured from oak, elm, hickory, ash, or whitewood; sometimes beech and sweet gum, though poplar is the most common. The saddle-tree business has declined somewhat in recent years, partly owing to the fact that there are fewer saddle-trees in use, but nevertheless, it is estimated that the twelve principal factories reported give employment to some four hundred persons, and represent an invested capital of a quarter of a million dollars.

Machines used in this industry are chiefly crosscut, rip, and band saws, tenoning and boring machines. After the wood work is made, the trees are covered with rawhide, or with mosquito netting pasted on, and these are strapped with iron; the trees that are hide-covered are usually nailed together, but the other kinds are joined with glue, and if the lumber is not seasoned is thoroughly kiln-dried. The labor is about two-thirds of the total cost. The lumber supply comes from Indiana, Ohio, and West Virginia. A manufacturer in Central Ohio, who uses oak and elm, says large brash trees of old-growth oak furnish excellent timber for the purpose, the heart of the tree being excluded. Elm is also used, and sometimes preferred, because it is less liable to split. When poplar is used it must be clear and soft and first class.

Hames.

Patent "Mine and lumber hame" from white oak, presented by Thomas Beagle & Son, Philadelphia.

Hames are made from white ash, oak, maple, hickory, and rock elm. Wood must be of best quality, clear and tough, and should be cut in the winter season. All parts of the lower portion of tree used. The lumber goes through fifteen different hands or processes before reaching the finished hame, though a manufacturer of steam-bent hames says: "These are handled twenty-five to thirty times from the slitting-saws to the packing boxes."

Stirrups.

Block stirrups of horse-chestnut. Donated by O. V. Flora, Madison, Ind.

White ash, black ash, hackberry, and other woods are also used. The stirrups are steam-bent, requiring a half a dozen different operations in manufacture, labor representing about one-half cost of goods when ready for market. Suitable timber for this purpose is said to be scarce. They are sold principally South and West.

Whip-stocks.

Whip-stock in holly and Osage orange. Presented by Messrs. Schneider and Pachtman, of Philadelphia, Pa.

III.—IMPLEMENTS OF INDUSTRY.

Into this division are grouped such machines or tools, wholly or in part of wood, as are used by man in purely industrial pursuits or in economizing human labor. For convenience the synopsis is arranged by occupations as follows:

A.—MINING AND EXCAVATING: Winch or windlass of hickory and oak, or other firm woods; ladders, oak and spruce, usually; pick, shovel, and other handles in hickory and white ash. (See also Shaft-sinking, Architecture, and Building.)

B.—FARMING AND DAIRYING: Windmills, pine, Norway pine; agricultural implements, in part of oak, ash, maple, hickory, whitewood, and pine; bee-hives and frames, pine, bass-wood, and poplar; churns and butter-workers, pine, spruce, maple, bass-wood, poplar; dairying implements in various woods.

C.—SURVEYING: Parts of tripods, rods, &c., maple, cherry, white birch, &c.

D.—WOOD-WORKING: Carpenters', cabinet-makers', and house-builders' tools or parts of tools, in various woods, as shown below.

E.—PRINTING AND ENGRAVING: Cases, cherry and whitewood; "furniture" and reglet, cherry; type, border, and rule, rock maple, cherry, and pine; engraver's woods.

F.—SPINNING AND WEAVING: Parts of looms, shuttles, persimmon, &c.; spools and bobbins, maple, white birch, apple, &c.

G.—Miscellaneous.

A.—MINING AND EXCAVATING.

This group was not represented except in pick and shovel handles, which, for convenience, are placed with "Articles relating to trade; C.—Turned articles."

B.—FARMING AND DAIRYING.

Agricultural implements (parts).

Scythe-snaths, plow-handles, and cradle-fingers, in hickory and white oak. Contributed by Pelton & Abell, Lowville, N. Y.

In manufacturing scythe-snaths only young growth wood is used, and as all knotty wood and all heart wood is rejected only a small portion of the tree is used. The material for the snath is split out of the right size to round up 2½ inches at one end and 1½ at the other, and 5½ feet long; they are then put in shape for the drawing-knife by having the surplus wood taken off with a band-saw, then shaved by hand round and as near a true taper as can be made by hand; they are then steamed until warmed thoroughly through, and forced into a cast-iron form of the proper shape and put into a dry-kiln, where they remain until thoroughly dry; then planed by hand with a spoke-shave until perfectly round. The irons are then fitted and they are finished upon the sand belt, varnished, and packed for sale.

Black cherry is sometimes used for the purpose. There are said to be fourteen snath and cradle manufacturers in the country, which are united in an association.

Plow-handles are usually made from first quality, clear, straight-

grained white-oak lumber. After passing through several saws from the log to the handle strips, the pieces go to a concave saw, which cuts a circular strip a foot in length from one end; another machine shapes the "hand hold," after which the "strips" are placed in the dry-sheds to season (from four to six months). Then they are steamed, bent, and upper edge rounded by machinery, polished, and finished.

The wood that enters into farm implements comprises but four kinds chiefly: hickory, oak, white ash, and poplar. Rock elm, bass-wood, and hard maple are used to some extent, particularly in the West, while pine is sometimes employed for special parts. A large establishment in Michigan, which manufactures plow-cultivators, harrows, and a line of similar implements, gives the following as the proportions of the different kinds used: White oak 50 per cent.; rock elm three fourths of the remainder, and hard maple about 12 per cent. The proportion of material to labor in this class of manufactures is about one-eighth to seven-eighths. An Ohio concern manufacturing twenty thousand implements annually, and consuming several millions of feet of lumber, uses over 50 per cent. of white ash (Ohio), nearly 35 per cent. of poplar or whitewood (Kentucky and Tennessee), the remainder, a little over 5 per cent. each, white oak and hickory from Ohio.

This lumber is first and second growth, cut at all seasons of the year, and all parts of the wood used that are sound and good. The woods average in price $20 to $25 per thousand feet in plank. The waste is about 10 per cent.

It is not generally known that the lumber from which plow-beams are made is air-seasoned from one to two years after being rough sawn into the shape of beams, a shed being used for the purpose. When finally finished they are given a heavy coat of linseed oil, and lastly varnished.

The J. I. Case Manufacturing Company, which uses about four million feet of lumber annually in the manufacture of its threshers, horse-powers, and saw-mills, draws its supplies from the following sources: Pine and bass-wood, Wisconsin; ash, elm, and maple, Michigan; oak, (and some ash), Indiana; poplar, Kentucky and Tennessee.

This company reports some nineteen factories engaged upon this special line of agricultural implements, with an estimated capital of $15,000,000.

Windmills.

Parts of windmills, in white ash and Michigan white pine. Donated by B. S. Williams & Co., Kalamazoo, Mich.

There is no special process or machinery employed in manufacturing wind-engines, ordinary wood-working machinery being used. The ash rims or felloes to the wind wheels are steamed and bent, then dried and cut to shape, and afterward soaked in hot linseed oil, to make them more durable. Norway pine is sometimes used.

Pumps.

Most common wood used is yellow poplar, oak being employed for

handles. The necessary machines are swing-saws, ripping-saws, tenon-machines, machines for making smooth valve-seats; augers for boring tubing and spout-holes; lathe; machine for dressing buckets; reamers, slotters for setting brackets. The lumber passes through about eighteen processes (or rather hands) before it is worked into a complete pump, ready for shipping. It is usual to thoroughly steam all material after it is bored and machine work is done on it. This removes the sap, as it dries out rapidly and prevents bad effects on water. The labor, including clerks, foremen, &c., represents about one-third of cost of product.

A pump-manufacturing firm at Greencastle, Ind., makes the following interesting statement:

The very best quality of clear poplar lumber is required for pump manufacture. The timber employed is among the most valuable varieties grown in our country, and while it is better adapted to the making of pumps than any other timber we know of, it is also so well adapted to nearly all purposes for which timber is used that the demand on it has been so great that it has become nearly exhausted in every section of the United States where it was found in greatest abundance. The main supply that is left will be found in a few of the Southern States, and within one or two decades it will be exhausted there. Our supply here is practically exhausted, and we expect from this time forward to get most of the supply from the South.

An association of pump-makers was formed in 1880, including 90 to 100 factories, with estimated capital of $1,000,000, and employing some 1,200 hands.

In connection with pumps, I may mention an industry peculiar to the oil regions of West Virginia, the manufacture of "sucker-rods" from ash and hickory, used as connecting-rods for pumping oil-wells. The logs are cut 28 feet long, and must be clean, sound, and A No. 1 in every respect. They are sawed into strips $1\frac{11}{16}$ inches square at one operation, on an automatic mill (two saws, one running perpendicularly, the other horizontally). They are then run through a four-sided molder or planer, made $1\frac{9}{16}$ octagon, and then are ready for market. No heart-wood can be used.

The superintendent of the Rowlesburg Wood Works, Rowlesburg, West Va., says:

For the past twenty years the Pennsylvania oil regions have drawn on Ohio for supply of above goods. Timber about used up. I have experimented with yellow pine, and find it adapted and eventually it will, I think, be used.

Bee-hives, and parts.

Bee-hive of Michigan white pine; brood and wide frames of pine, bass-wood, and whitewood. Donated by A. I. Root, Medina, Ohio.

Mr. Root states that nearly every grade of Michigan pine and usual log run of bass-wood, winter cut, is used. Bass-wood and poplar come from Ohio. Prices average $10 to $40 per M for pine, and $10 to $20 for other woods; there has been an increase of 25 per cent. in cost of bass-wood in ten years. Notwithstanding the increase in cost of bass-wood, Mr. Root is of the opinion that the supply will be equal to the demand for a long time to come, as it grows rapidly and, compared with other kinds of lumber, is but little used by manufacturers; in fact, he

says, there appears to be more offered now, and of better quality than ten years ago.

There are about fifteen manufactories in the United States; capital and hands employed not estimated.

Churns and butter-workers.

These are of infinite variety, employing many forms, including some that would classify the manufacture with cooperage. Yellow poplar, pine, maple, bass-wood, and black birch are the woods commonly used, poplar and pine being employed for receptacle and the other woods for frames and parts.

Rake, fork, hoe, and other handles. (See Articles relating to trade; C.—Turned goods.)

Usually turned, one machine only being used; after wood is brought into rough state, care must be used after turning to keep the handles in a dry, dark place.

Ox-bows.

"In the manufacture of ox-bows, sap-wood of hickory, with the inner bark on each piece, is only used."

C.—Surveying.

Tripods.

Compass-tripod in cherry; extension tripod in yellow birch. Presented by W. & L. E. Gurley, 514 Fulton street, New York.

Rods.

One New York rod in hard maple; one Troy rod in cherry; architect's rod in maple, W. & L. E. Gurley, as above.

This firm also manufactures drawing instruments, T-squares, flag-staffs or ranging-poles, drawing-boards, packing-boxes, &c., using the best straight-grained lumber in cherry, maple, beech, pine, and spruce. Considerable mahogany is also used for instrument-cases. The plant of an establishment of this kind includes power planing-machines, jointing-machines, circular saws, with all the modern attachments, shaping-machines with dovetailing attachment, gig-saws with adjustable tables, gauge-lathes for turning tripod-legs, and sandpapering-machines.

Cheaper forms of tripods are sometimes made of white ash, and instrument-cases of cherry.

D.—Wood-working tools.

Plane-blocks.

One set of seven bench-planes in beech and apple, illustrating different stages of manufacture. H. Chapin's Sons, Pine Meadow, Conn.

One set from John Cotton, 247 South Second street, Philadelphia.

One set from Auburn Tool Company, Auburn, N. Y.

Large collection of bench and other forms of planes in series, from Sandusky (Ohio) Tool Company.

The woods employed in this series are white beech, apple, hard maple, oak, hickory, and foreign woods, such as rosewood, ebony, lignum-vitæ, &c. In addition to planes, the Sandusky Tool Company manufactures

all descriptions of cabinet-makers' implements, planters' hoes, awls, and other small tools, ice-tools, bench-screws, hoe, hatchet, hammer, and saw handles, and coopering instruments. From two to three hundred car-loads of white-beech timber are required for planes, which is cut in the northwest counties of Ohio and Michigan.

The ash for 10,000 dozen of hoe-handles is annually secured from the adjacent counties, while 40 to 50 car-loads of sugar-maple are annually made up into bench-screws and similar wooden instruments. Twenty to thirty car-loads of hickory are used in the construction of handles for small tools, while of apple, boxwood, rosewood, ebony, and lignum-vitæ from 50 to 60 tons are constantly kept on hand for the manufacture of croquet-balls, fancy planes, panel floors, &c. A stock of beech and maple is kept for two years ahead, which by additional dry-kiln facilities is most thoroughly seasoned before being used, for if the slightest bit of heart-wood appears in the cut the plane is marked a second. The sap or white part of thrifty second-growth trees is chiefly used.

Wood screws.

Series of wood screws, clamps, &c., from Milton Aldrich, Lowell, Mich. Screws of white hickory; frames, beech, white birch, and hard maple. Also set of screws from Auburn Tool Company.

A good quality of hickory is required, but not confined to second growth. Mr. Aldrich writes that the hickory used in his establishment comes from Maine, New Hampshire, Massachusetts, Ohio, and North Carolina, and costs from $50 to $150 per thousand. The beech, birch, and maple are received from home sources. In making wooden screws the log is first cut to proper lengths, split through the center, and the pieces sawed out as desired. These are stored for a season, then taken and treated with steam and dried, it being desirable to dry as far as possible by natural heat. When dry they are returned to the factory and worked into the different parts which go to make up the wooden screws. Woods pass through planing-machines, lathes, cutting-machines, a boring-machine, sandpapering, beading, and grinding machines, screw tools, &c.

The wastage is 30 per cent. for the logs or planks, with a subsequent loss of 10 per cent. for dimensions.

Spirit-levels.

In cherry, from H. Chapin's Sons, Pine Meadow, Conn.

Spirit or mechanics' levels are usually made of mahogany or rosewood, or some of the denser foreign woods. When native woods are employed, however, black cherry is preferred, of the best quality, heart-wood only of old growth being used. Messrs. Stratton Brothers, of Greenfield, Mass., state that only about 20 per cent. of native lumber is used in this industry.

Gauges.

A series in maple was contributed by H. Chapin's Sons, Pine Meadow, Conn.

Rules.

Bass-wood foot-rules for advertising purposes, Milton Bradley & Co., Springfield, Mass.

Apple-wood rules from H. Chapin's Sons, as above.

These advertising or penny rules are made in two styles, the international with metric system, and the ordinary mechanics' rule in inches and subdivisions from fifths to sixty-fourths. The advertisement is printed upon the back.

Mallets.

Series of hickory mallets, from the Sandusky Tool Company.

Saw-handles.

A large series of saw-handles was donated from H. Disston & Sons, Philadelphia. Outside wood only is used, the kinds being apple, beech, cherry, and black walnut.

Other handles. (See Articles relating to Trade; C.—Turned articles.)

E.—PRINTING AND ENGRAVING.

Wood type.

One large series of wood type letters, borders, &c., in hard maple, handsomely mounted. William H. Page Wood Type Company, Norwich, Conn.

Wood type in hard maple, from Hamilton & Katz, Two Rivers, Wis.

Mr. George C. Litchell, president of the William H. Page Wood Type Company, in reply to the request for information, makes the following interesting statements:

We manufacture wood type, borders, quoins, printer's furniture, engraver's woods, job sticks, and wood rules, using rock maple for wood type and borders, boxwood and hickory for quoins, cherry and pine for furniture, boxwood, mahogany, pine, and rock maple for engraver's woods, mahogany for job sticks, rock maple for wood rules. Rock maple and hickory are received from Connecticut, the boxwood from Turkey, and the cherry from Pennsylvania; our pine comes from Michigan, and mahogany from Cuba.

The rock maple and white pine for general uses are first growth, and the best wood that can be obtained. It may be explained that wood type, borders, and wood rules are used for "show-bill" printing; boxwood, mahogany, pine, and rock maple for engraving purposes; quoins for locking up forms on printing presses; furniture for spacing between lines of forms; job sticks for setting up lines of type.

The hardest of second-growth rock maple is used exclusively for wood type, and is all used alike without regard to sap, as there appears in maple no sap or part different from main body of the wood. The heart or center of log is not used. We prepare the wood by cutting it up across the grain in 1⅛ thickness. The best maple is native of Eastern Connecticut. We have tried maple from other parts of the country, but none so good as our pasture-grown maple, the logs being split through in the middle at a saw-mill and delivered in half logs. Waste in manufacture, 25 per cent.

Wood for type is sawed up in the green state and first boiled in water, then dried about two years; then subjected to fire heat for six weeks or so; then dressed out type high and finished on the one side for face, and sawed into strips of lines pica to suit the size of type to be made, and then letters are cut by machinery, and the last process is to look them over and hand-finish what the machine does not do; then they are oiled with linseed oil and packed and shipped. Labor represents 80 per cent. of cost.

Engraver's woods.

The most common wood in use is Turkey boxwood, mahogany being also employed to some extent. Samples of engraver's blocks in hard maple were donated by Vandeburgh, Wells & Co., New York City. Samples were also received in pine and "American boxwood," Longacre & Co., Philadelphia, Pa.

(Inquiries were made of Messrs. Longacre & Co. for definite information concerning this wood, but no replies could be obtained.)

Reglet, furniture, &c.

Series of cherry reglet, &c., from Vandeburgh, Wells & Co., Fulton street, New York. The firm also contributed series of type cases.

F.—Spinning and weaving.

Shuttles.

Shuttles in apple, dogwood and persimmon, with wood in rough. Presented by the North Carolina Shuttle Works, Bush Hill, N. C.

Bobbins.

Collection of bobbins in hard maple from Michael Quinn, 332 Master street, Philadelphia, Penn.

Spools.

A collection of spools from L. H. Dwelley, Foxcroft, Me.; birch. (See also Articles used in trade; C.—Turned articles.)

The following interesting letter is received from Mr. Dwelley:

In compliance with your request of the 2d intant I herewith make a few statements regarding spool manufacture, the spools being used principally for sewing silk, linen and cotton thread. I also manufacture turned wooden boxes, and various other articles in which only second-growth white-birch wood is used, as from its special character it can be worked with greater economy than any other wood known to the writer.

White birch is found in great quantities in Piscataquis County, Maine, my supply being obtained within a radius of 20 miles. It is found growing from size of the smallest sapling to 20 (sometimes more) inches in diameter at a few feet from the ground. It is a common practice to leave all the trees standing that are less than 6 inches in diameter, thus cutting only the larger growth and allowing the smaller trees to grow to suitable size before being cut.

I am using annually about 2,500 cords of this wood, making, when sawed into squares of suitable sizes to make the various sizes of spools, &c., from 1,000,000 to 1,200,000 feet (board measure) of spool stock. These square sticks, which are usually cut in 4-foot lengths, are first thoroughly seasoned in the open air, after which the timber may be kept for any length of time, if not exposed to moisture. White birch, however, must not be allowed to remain in logs with the bark on in hot weather, unless kept in the water, as it will commence to decay in an exceedingly short time, rendering it unfit for use; consequently I have all my spool timber prepared during the cold weather, of which there is no lack in this latitude. After the stock is sawed in the 4-foot lengths and properly seasoned, the pieces are cut into short blocks and then are dried in a hot-air kiln. When again sawed a hole is bored through them. One whirl of the block against a set of sharp knives, shaped by a pattern, makes the spool, at the rate of one a second. The spool-machine is fed by a boy, who places the blocks in a spout, throwing out all that are knotty or defective. In polishing, the spools are simply revolved rapidly in drums and finish themselves.

G.—MISCELLANEOUS.

Shoe-lasts and boot-trees.

One set of shoe-lasts in second-growth sugar-maple, contributed by Messrs. Wing & Smith, Burlington, Vt.

Another set in sugar-maple, persimmon, and apple wood, from Crawford, Coffman & Co., Dayton, Ohio. This firm also donated crimping-boards in maple.

Messrs. Wing & Smith state that lasts are manufactured from both dry and green maple; the dry is air-seasoned, the green by steam heat, the blocks dried by air requiring a year or more time, the green blocks ten to fifteen days.

They use the Gilman & Townsend last-grading lathes, manufactured at Springfield, Vt., for lasts; for boot-trees, those of their own construction.

The process of manufacture is as follows: Logs are sawed in lengths required for lasts of the sizes we are turning; split and hewn to proper size, then turned, after which they are put in a steam dry-house, where they remain from ten to fifteen days; then put on racks, where they remain until wanted to finish. The finishing is: First, sawing the blocks; second, cutting heels and toes; third, shaving same; fourth, scouring on wheels; fifth, polishing; sixth, strapping and tying up; seventh, boxing.

Blocks dried by the elements are not white, as the process of drying is slow, but in the case of steam-drying they are as white as the wood in its natural state; further, steam-dried lasts are susceptible of a very high polish.

This firm uses but little persimmon wood, owing to its expensiveness. Very few boot and shoe makers are willing to pay the difference in price, the cost of the lasts in the rough (turned lasts) being about 30 cents per pair; when finished maple lasts can be sold for 20 cents. Birch lumber, such as used for crimps, costs about $30 per 1,000 feet. All turned lasts require models for the lathes, and the same must be made by hand. Good last-model makers require many years' experience. The eye has much to do in making a good model, as well as taste. Fashions change so often a model-maker must be able to make any style required, and he must also be a person of quick perception and possess an artistic eye. Special lasts for deformed feet are often required.

Messrs. Crawford, Coffman & Co. state that they use the lower and clean part of rock-maple trees, principally, cut at all seasons, though they think the lumber is best cut between June and November. The sap-wood forms the main body of the last, leaving only a small amount of heart, usually none, on the top of the last. It is further stated that the seasoning process is a difficult and delicate one, owing to the liability of checking, or injuring the fiber of the wood. If dried too slowly it takes a stain; or if dried too rapidly, the wood becomes porous and

brittle. The last, from the log of wood to a finished article, passes through or over about seven machines and fourteen distinct operations, labor being about 50 per cent. of the cost.

There are said to be some seventy or more last-making establishments in the United States, with an invested capital of $1,000,000.

Shoe-pegs.

Shoe-pegs are made from white and silver birch and white maple, only the best-selected bodies of trees being used. The wood is cut and hauled as wanted, the sap-wood being used, and the heart or red part removed and thrown away.

A New Hampshire shoe-peg manufacturing firm that produces 40,000 bushels annually uses second-growth birch, which is considered a quick-growing timber; and it has been found that the supply equals the demand in the particular section where the mill is located. The wood is worked green and seasoned in the process of manufacture. A shoe-peg goes through eighteen different hands or processes, and 75 per cent. of cost is labor.

There are not over ten shoe-peg factories in the land, employing perhaps 200 hands, and with a capital of $125,000 to $150,000. Large quantities of shoe-pegs are exported.

Hat-blocks, wig-blocks, &c.

Collection of wig-blocks in gum; hat-block and hat-flanges in poplar, curling-board in poplar; hat-stretchers (wood unknown), manufactured by Christian Nonnenberger, 323 Race street, Philadelphia, Pa.

Mr. Nonnenberger makes the following interesting statement regarding hat-blocks:

For our work the wood must be perfect, as cracked lumber we cannot use. Indiana poplar is preferred, though it is getting very scarce, so that we are obliged to buy it three and four years in advance in order to have it properly seasoned. The wood is placed in a room with coal fire burning night and day to dry it. The different machines through which a hat-block passes: band-saw; circular saw; gig-saw; planing-machine; turning-machine; oval-machine; curving-machine, then finished by hand, passing through four hands. Other manufactures are: flanges used for shaping the brim of felt hats; curling-boards for shaping brim of silk hats; stretchers for enlarging hats; hat-sets, used, one to lengthen and one to widen a hat, according to shape of wearer's head.

IV.—USES OF WOODS IN ARTICLES RELATING TO TRADE.

Into this division are grouped a large class of articles used in trade, the majority of which find employment only as packages or receptacles for merchandise, and many of which are used but once, and then thrown away or destroyed. In some instances, however, as with certain kinds of cooperage, basket work, or measures, their use in store or warehouse may be more or less continuous. Among exceptions should be noted hard-wood veneers, which, on some accounts, might be more readily classed with furniture but for the fact that veneers or thin-cut woods

are used at the present time in so many different forms directly relating to trade. The group of wood industries is arranged as follows:

A.—COOPERAGE (shooks, staves, heads, and hoops): Tanks and vats, cedar, spruce, white and yellow pine, cypress; sugar-hogsheads, oak, maple, beech, and birch; flour, fruit, and provision barrels, red oak, ash, bass-wood, white oak, red, white, and rock elm, beech; heads, bass-wood, white and red oak, ash, maple, birch, butternut, hickory, and poplar; fish and lard, second-growth white pine, &c.; molasses, sugar, and liquor, white and red oak, elm chiefly; sirup, bass-wood, pine, oak, and other hard woods; nail-casks, spruce with pine heads; butter tubs and firkins, oak, spruce, hemlock, ash; fish-kegs, maple, pine, ash, &c.; spice-kegs, chestnut; oyster-tubs, spruce and oak; paint and lead tubs, kegs, and pails, white and red oak; pails, tubs, &c., for domestic use, oak, ash, cedar, cypress, pine, and spruce.

B.—SPLIT AND SHAVED WOODS: Wood measures, sieve-rims, &c., oak, beech, and maple commonly, sometimes bass, poplar, cherry, and white birch; cheese-boxes, oak and elm, white elm, bass-wood, and poplar headings; basket work, oak, ash, pine, &c.; barrel-hoops, oak, ash, elm, hickory, and various hard woods; fish-fykes, hickory and oak.

C.—TURNED ARTICLES: Handles in various woods, wooden pill and chemical package boxes, white birch; match-boxes, pine, poplar, &c.; package cases, white birch; bungs and plugs, poplar, pine, &c.; button-molds, maple and birch; faucets, beech, birch, and maple; dowells, maple, white and yellow birch, beech, &c.; sugar and other scoops, maple and willow; map, chart, and other rollers with knobs, bass-wood, ash, cherry, and maple; spool and braid rolls, ribbon-blocks, &c., white birch.

D.—VENEERS: Furniture veneers in all hard woods; "perforated" veneer work for chair-bottoms and similar uses, ash, maple, oak, walnut, &c.; lard, butter, and pie plates and trays, sweet-gum, beech, birch, and maple; match-boxes (squares), pine, beech, and birch; wall hangings, all hard woods; excelsior, bass-wood, birch, poplar, cottonwood, and buckeye; paper-backed inlaid veneers, for decorative purposes, all fancy woods; sorrento carved panels, all fancy woods; business cards, cross-section, hard woods.

A.—COOPERAGE.

Kegs.

One one-fourth anchovy keg in maple wood, with willow hoops; one one-half gallon oyster-keg, ash throughout; one Russian sardine-keg, maple wood, with maple hoops; one spice-keg (small size), chestnut throughout; from William S. Robinson, New Haven, Conn.

Series of white-oak kegs, lead and paint buckets, &c., from Hill & Wright, East Boston, Mass.

Tubs and pails.

Oyster-tubs (sometimes called pails), in spruce and in white oak, with pine covers; also, butter-tubs, in white ash, with black-ash hoops; William S. Robinson & Co., New Haven, Conn.

One spruce tub, use not specified, from Frank E. Vaughn, Elizabeth City, N. C.

Spruce butter-tubs, Flanders and Son, Parishville, N. Y.

Butter-tubs, in white ash and white oak, with hickory hoops; presented by D. C. Mason, Fulton street, N. Y.

While the processes for manufacturing all kinds of cooperage are in the main similar, a few descriptive notes will not be out of place. Mr. W. S. Robinson, of New Haven, illustrates the subject by giving the different steps in the manufacture of an oyster-tub or shipping-pail as follows:

In making oyster-tubs I use nine machines besides the large tub-lathe, which is a combination machine. Three and four inch plank is first cut right length for staves on circular saw; then sawed in right shape on barrel-saw, kiln-dried; then both ends sawed off at once, making it exactly right length; then sawed lengthwise, both sides (jointed we call it) to the right shape; then matched to each other with tongue and groove, like flooring; then set up in ring and put on to the lathe one side and turned smoothe on the outside, and on the other turned smooth on the inside, and groove cut for bottom. Bottom and cover turned on another machine. Hoops are cut off and two holes punched for rivets by one machine, flared by another, and bent by another. We have a press for making most of the iron trimmings, but handles, part of bail-ears, and staples we buy. Proportion of labor to cost is one-half or a little less to nearly two-thirds on some sizes. The labor is a larger proportion of cost on small packages than large ones.

Butter and lard tubs are made from white and black ash timber, bass-wood, spruce, hemlock, oak, pine, elm, maple, &c., old trees being preferred. Sometimes made of sycamore, though not to any extent, owing to comparative scarcity.

Casks and barrels.

Barrels in southern pine; Philip Hirsch, New Orleans.

Oak and whitewood barrels, staves, heads, &c.; Grand Rapids Stave Company, Grand Rapids, Mich.

White-oak casks and yellow-pine barrels; from A. F. Page & Sons, Blue Crossing, N. C.

Barrels, barrel-hoops, head-linings, &c.; Burrel & Whitman, Detroit, Mich.

Casks in white oak, for beer, ale, and liquors; Hill & Wright, Boston, Mass.

In making a liquor or other cask, the material is prepared in the same manner as described above (see Oyster-tubs). Staves are dressed, jointed, raised in truss-hoops, heated or steamed, ends pared and finished, heads made and put in, and after hooping it is subjected to heavy air pressure from a pump to ascertain if it is perfectly tight. A Southern manufacturer says that sap-wood should not be used for liquor staves, though it may be used for pork, lard, pickle, oil, sirup, and other casks. Flour-barrel staves, for the Minneapolis trade, are made principally from red oak, elm, ash, and bass-wood; barrel-headings from bass-wood. The following interesting description is given of the necessary steps in the manufacture of so simple an article as the head of a flour-barrel:

The wood comes to the mill either in logs or bolts, the latter being blocks of timber split out of the log to the required length. Bolts cut from basswood logs 38 inches in length, peeled and delivered to mill, where they are cut in two, with cut-off saw, then cut into cants five-eighths of an inch thick with heading-saw, dropped on chain carrier and conveyed to cars in front of dry-kilns, on which they are piled; then passed through dry-kilns, requiring from forty-eight to sixty hours to dry same; still on cars the bolts pass down track to planer in heading-mill; the pieces are then planed and brought to one-half inch thickness; then jointed and pass to watchers, who place sufficient number of pieces together to make a head; each set of pieces is then placed in heading-turner, clamped, and circled to proper size. As it falls from clamps the pieces composing each head are picked up by a boy and placed in a holder, and from there they go to the packer, where they are done up in bunches containing 12½ sets to the bunch; iron straps sometimes used, and sometimes tarred string.

Tanks.

One spruce tank, wood from Michigan (made also of cedar, cypress, and hard pine); William L. Philbrook, Boston, Mass.

Cooperage for household use.

Flour buckets in white pine; United States Truck Company, Detroit, Mich.

White and red cedar pails and tubs and white cedar dash-churns; from New York Cedarware Company, New York City.

Red and white cedar tubs; Clement & Dunbar, Philadelphia, Pa.

Wash-tubs in white pine, water-pails, flour-buckets, &c., white pine, barrel covers, &c.; Wilder P. Clark, Winchendon, Mass.

Ice-cream freezer, pine; from the White Mountain Freezer Company, Nashua, N. H.

Shooks.

Sugar-hogshead shooks, made principally from oak, maple, birch, and beech. The hogsheads are made and put together, then knocked down, and the parts packed in bundles ready for shipment to sugar-producing countries. A large Eastern manufacturer writes:

When I went to my trade, forty-five years ago, we used to get quite a supply of stock from Maine and New Hampshire, particularly of red oak for sugar and molasses shooks. That supply has failed us for twenty years or more, and the shook trade for Cuba has gone from Maine and across to the West. Hundreds of men were formerly employed in those two States, and now there are none. Lumber for a shook costs about 50 cents; labor about 27 cents. The shook passes through four different machines and five hands from log to finished article.

Following list of woods used for cooperage, with principal articles of manufacture:

White pine.—Pails, tubs, keelers, churns; fish, lard, and sirup packages (kits, kegs, and barrels), tanks.

Yellow pine.—Tanks and vats.

Spruce.—Nail kegs and casks, lime and cement barrels, butter and sugar tubs, oyster-tubs, &c.

Poplar.—Churns.

Cottonwood.—Flour and sugar barrels, and barrel-heading.

Cypress.—Tanks, tubs, and vats.

Red cedar.—Pails and tubs, chiefly for domestic use.

White cedar or juniper.—General "cedarware," as tubs, pails, measures, butter-churns, tanks, vats, and reservoirs.

White ash.—Oyster-kegs, butter tubs and pails, flour and fruit barrels, hoops.

Black ash.—Butter and lard packages, hoops.

Basswood.—Sirup-packages, flour-barrels, but mainly flour-barrel headings.

Birch, (variety not stated).—Sugar-hogsheads, flour-barrels.

Beech.—Sugar-hogsheads, lard-packages, butter pails and tubs.

Chestnut.—Butter-pails, spice and other small kegs, headings small kegs.

Wild cherry.—Butter-tubs.

Elm.—Flour and sugar barrels, butter-tubs.

Maple. — Flour-barrels, lard-tubs, sap-buckets, butter-pails, sugar-hogsheads shooks), fish and other small kegs, keg-hoops.

Butternut.—Flour-barrels.

Sycamore.—Butter-tubs and barrel-headings.

White oak.—Shooks for molasses and sugar hogsheads and barrels, butter-tubs, beer and all barrels, kegs and pails for white lead, paints, &c., oyster-tubs, well-buckets, liquor and other casks, tanks, and barrel-headings.

Red oak.—Flour-barrels, chiefly.

Hickory.—Flour-barrel headings and hoop-poles.

The quality of lumber varies with the use, "first quality" being usually reported, though in some cases manufacturers are careful to state "best quality of second growth," the trees felled in the winter

months. Little or no difference is made in the portions of tree used, as heart or sap, so the wood is sound. In some New England manufactories where a cheaper grade of pine cooperage is made "sapling pine" of home growth, good, bad, and indifferent, is used. The sapling pine is drawn to the mill-yard cut in lengths of about twelve feet. Large logs are split with upright mill-saws; others cut in length by circular saws leaving the joints or knots (which are usually in circles about the log) as waste wood. These blocks are from fifteen inches to six inches in length. After sawing into staves they are piled in the mill-yard, and when dried are packed in sheds until wanted for use, and put in dry-house. Bottoms for pails and tubs are cut from such lumber as seems best adapted for the purpose, when sawing is being done, usually from the largest logs.

A manufacturer in Winchendon, Mass., who was asked his opinion regarding the supply of white pine in his State for cooperage purposes, says:

> White pine is of rapid growth. There are large amounts grown and cut in this section, and from some standpoints it may seem that waste and destruction are going on at a fearful rate, yet from the best information that I am able to obtain I judge that in this town and vicinity there are as many cords of sapling pine suitable for use as there have been at any one time for the past forty years; of course old-growth pine is very scarce; in fact, all timber of old growth is becoming very scarce.

B.—Split and shaved woods.

Measures and round nest-boxes.

Dry measures, one complete set; nest-boxes, several sets, presented by Gage & Co., Henniker, N. H. These are: rims, white oak; bottoms, white pine.

Series of fruit, salt, and axle-grease boxes, in pine and hard woods, from Thomas Annett, East Jaffrey, N. H.

These boxes and measures are made from a variety of hard woods that may be cut into thin, broad strips and bent in circular form. Beech, birch, white ash, elm, hard maple, and white oak are used for hard-wood portions, the bottoms and covers being made of sapling pine of native growth. The pine log is sawed into boards one-fourth of an inch thick, kiln-dried, planed, and then cut into circular pieces from six to ten inches in diameter, for tops and bottoms of the different boxes. The hard-wood log is sawed into blocks, then steamed and sliced into thin strips for the body of the box. These strips are bent into circular form, the ends tacked together, and the circular heads driven into the bottoms and fastened by wooden pegs. Covers are made from narrow strips in a similar way. The boxes are next sand-papered, which is the finishing process, except for the best qualities, which are varnished. The finished box has passed through twelve different machines. Proportion of total cost representing labor, 60 per cent.

Bent wood is also manufactured into churns, white ash being employed. Other manufactures are drum-hoops, banjo, tambourine, and

basket hoops, sieve hoops, coal-hoops, riddle-hoops, children's rolling-hoops, and cheese-boxes. An Eastern manufacturer states that drum shells, formerly made from wood entirely, are now made mostly of metal tin, brass, and German silver being used. In the manufacture of children's rolling-hoops, beech, maple, and oak are largely used, lumber and labor each amounting to one-third of cost, the remaining third being represented by cartage and freight and profit. The following stages are given in the manufacture of a child's hoop: (1) Log sawed; (2) plank sawed; (3) strip planed; (4) strip tapered on saw; (5) strip split (making two hoops); (6) edges planed; (7) steamed; (8) bent, 12 sizes; (9) tacked; (10) laps smoothed on sand-wheel; (11) sandpapered; (12) nested or packed in one-half gross bunches, the sticks for driving them being boxed in one-half gross package and secured to inside of circles. A rim and hoop manufacturer of West Chesterfield, Mass., makes the following reply as to parts of tree used:

Of maple we use old growth for thin and wide hoops, where it works well. For banjo and other thick hoops, snare-drum rims, &c., we have to use second-growth maple exclusively, on account of toughness and superior bending qualities. Sometimes soft or white maple is used in place of second-growth rock maple, but only in case of very nice log.

All heart lumber contains more or less knots, and is of little use for hoops of any kind, and we use it for turned goods (hammer-handles, drum-sticks, and toy ball-bats).

Baskets in split wood.

Mill baskets in white ash. Donated by E. H. Goodrich, Hinsdale, Mass.

These are also made from bass-wood of first quality, cut at any season. In preparing the wood for basket-making the log is split as near the eye as possible, shaved to the proper thickness, pounded with a heavy hammer on an anvil; the stick is then held in such a position across the anvil that by pounding it the grains are loosened, so that they can be pulled apart; these strips are then smoothed and braided on blocks, which, after being dried, are tightened and are ready for the rims.

Hoops.

Hay, hogshead, and barrel hoops, from yellow ash, are made in a similar manner, the logs being quartered, split into bolts 2 by 3 inches (with the grain), then passed between two wooden rollers run by horse-power, which separate the grains, leaving the hoop when finished $\frac{3}{16}$ of an inch thick and 10½ feet long.

C.—Turned articles.

Handles.

Hammer, pick, and sledge handles in hickory, awl and file handles in hard maple and whitewood; W. W. Gillette, Bozrahville, Conn. (ornamental case).

Hammer, hatchet, ax, and other large handles, from white oak and hickory: Horatio Kelsey, Clinton, Conn.

Handles of tanner's and shoemaker's tools, in hard maple and cherry; William H. Horn & Bro., Philadelphia, Pa.

Tool handles of various kinds, with illustrations of the wood in the rough, as well as turned, from B. B. Warren & Son, Plainville, Conn.

The woods represented are as follows: Butternut, cherry, white oak, chestnut, bass-wood, yellow birch, hard maple, sassafras, elm, white pine, red cedar, and beech.

Hickory chisel and other handles, from Sandusky Tool Company, Sandusky, Ohio.

Cylindrical brush-handles, in hard maple, white ash, walnut, &c. Estate of C. B. Rogers, Deep River, Conn.

In the manufacture of pick and sledge handles, the timber being received at the factory in the log, and cut usually 37 inches in length, is first sawed into quarters and afterwards sided up to the proper size for turning, sledge-handles being sometimes made from the sidings or "slabs" from the pick-handles. It then goes to the turning-machine, which brings the handle to shape, but leaves the surface quite rough. It is then placed upon a canvas belt coated with coarsely pulverized flint or quartz, which quickly removes the outer surface, but leaves the handle still much too rough for market. It then must be thoroughly seasoned if this has not already been done. Many prefer to season the timber before turning. If seasoned after turning, the handles must be looked over once or twice, and such as need it straightened. If this is neglected until the timber becomes too dry, the handles must be put for a short time into warm water, or exposed to steam. They can then readily be straightened, and after becoming again somewhat dry, the ends are smoothly sawed off and the handles again passed over a canvas belt coated with fine sand. If a fine finish is desired, they are the third time passed over the sand belt, and this time a composition of white lead, rosin, beeswax, and oil is applied to the belt, which fills the pores of the wood and adds very much to its appearance. The handles are now ready for casing and market.

Ax, pick, sledge, hammer, and hatchet handles are usually made from best forest and second-growth hickory (shellbark, black and white hickory), the best of the butts being used. These are shaped and the seasoning or drying done in darkened rooms, no steam being used, as the steaming process destroys the elasticity of the wood. The finest handles are hand shaved. Hoe, rake, D-shovel, and fork handles are made from white ash chiefly, though hard maple, beech, and even hickory are employed by some manufacturers. Shovel-handles, however, are always of white ash. A large Western manufacturer states that shovel and fork handles require timber not more than two logs from stump and only the best portions, as the soft, light timber, of which there is much in ash, is not tough enough for good handles.

Broom-handles are made of white ash and other hard woods, but usually of bass-wood as lighter and cheaper, while fully answering the purpose. One thousand feet of good lumber will make 2,000 broom-handles of No. 1 quality.

Tool-handles, such as chisel, file, awl, graver and other small handles

are made from a great variety of woods, according to use, even fancy foreign woods, as cocobolo, rosewood, &c., being employed for fine handles. Maple and ash seem to have the preference for chisel and general small tool handles; hickory and ash are used for spinning tools; graver-handles are made from maple, apple, &c., and file-handles are considered sufficiently good when made from poplar, bass-wood, and similar softer kinds. Oak is sometimes used for small tool-handles, though not so largely as many other kinds of tougher woods. Brush-handles (paint, varnish, &c.) are also made of different varieties, according to the kind of brush. Maple, birch, white ash, hickory, black walnut, cherry, sycamore, elm, oak, red cedar, and poplar are all employed in this industry. Of foreign woods may be named satinwood, rosewood, cocobolo, olive, ebony, tulipwood, and mahogany.

Wood faucets.

Wood faucets, hard maple; E. Loud & Co., Winchendon, Mass. Wood faucets in red cedar and locust; Frances Threm, 596 Walnut street, Cincinnati, Ohio.

These are also made from beech, birch, and maple. A prominent Massachusetts manufacturer also uses about 25 tons of lignum-vitæ in his factory in a year. There are many forms of faucets, patent, metal lined, &c., but it is not necessary to mention them here.

Map-rolls.

Sets of map rolls and moldings from bass-wood and hard maple were donated by M. P. Mason, Carthage, N. Y.

Ash, cherry, and similar woods are also used. A map-roll goes through ten different processes (hands and machines) in course of manufacture. This factory turned out 800,000 sets of map-rolls—one roller, one molding, and two knobs—in a single year. The larger quantity were made of bass-wood.

Match-boxes.

Round wooden match-boxes are made from white pine and poplar, either first or second growth. Match-boxes are turned by machinery, one machine making the box and another the covers, though either machine can be gauged to make boxes or covers. Each machine is capable of making 10 gross of boxes per hour. The boxes are taken from the lathes and rattled in a revolving cylinder, which cleans and polishes them, and separates them from chips, &c.

Dowels.

Dowels are made in regular lengths of 3 feet, used for furniture, toy work, umbrella-handles, &c. Woods commonly used are hard maple, beech, white and yellow birch, and sometimes ash, elm, and other woods. In sawing lumber for dowels, about $\frac{1}{8}$ inch is allowed for shrinkage and waste. After the wood is properly seasoned, it is turned on dowel-machine, which makes from five to six thousand per day of ten hours. Dowels are not only sold throughout the United States, but are shipped to Europe and Australia.

Spools and bobbins.

A "Whittier New Model" or Sawyer or Rabbeth spinning bobbin goes through 29 different processes from lumber to finished article, and is sold at three-fourths of a cent, or at the rate of $7.50 per thousand. The material is three-sevenths of the total cost, the balance being labor and profit. The bobbin goes through twelve machines from first to last. Sap-wood only is used.

The Willimantic Linen Company (Connecticut) give the following as the practice in the manufacture of spools in their establishment, the white part of white birch that is free from knots being used:

Trees are cut down, sawn into 4-foot lengths, drawn to the mill by horses, sawn into square bars by circular saws, timber then stacked in yard to dry; thence taken to dry-kiln, heat applied, air drawn out, passed through a condenser, which relieves it of its moisture, and then returned to the kiln by means of a blower; wood then passed through a swiftly-revolving chuck and hollow arbor, the chuck holding knives which reduces the stick to a round form; thence taken to a gang of saws which cut it into the proper lengths for spools; thence by an elevator the blocks, as they fall from the saws, are carried up one story and deposited in hoppers; from thence they are fed down a conductor to the machine which bores a hole in the center of each block, the feeding and boring being done automatically; thence conveyed to another hopper and fed down into a lathe which turns the spool, after which they are put into revolving drums and polished by friction, and when sorted are ready for market.

Miscellaneous.

An infinite variety of turned goods might be mentioned, such as chemical boxes, pill-boxes, button-molds, toys, and ornaments of every description.

D.—VENEERS.

Hard-wood veneers (for cabinet-work).

Series of hard-wood and fancy veneers, arranged in panels, presented by Palmer, Parker & Co., Boston, Mass. This series includes the following: Bird's-eye maple, white ash, corrugated cut; white ash, blister; oak branch, butternut, burl, cherry burl, California laurel burl. California redwood burl, maple blister, walnut stripe, plain walnut, curl walnut, mountain ash, curl; hard maple, plain; holly, walnut burl, and cherry blister.

From the Grand Rapids Veneer and Panel Company was received a series of veneer panels showing elm, hard maple, white ash, black ash, sycamore-black walnut, red oak, black birch, red birch, cherry, and white birch.

Veneers are of two kinds—the sawed veneers, where an entire log is reduced to thin sheets in the same manner that boards are sawed, and the rotary-cut veneer, where a knife travels around the circumference of the log, reducing the lumber to continuous sheets, which are afterwards cut into squares of any desired size. The knife-cut veneers run from the thickness of 120 to the inch to five-sixteenths of an inch. The entire log, with the exception of about 8 inches of the center or heart, is cut up.

Chair bottoms.

Perforated chair-bottoms, in three layers of veneer woods, so arranged that the grain shall run in different directions; used also for car ceilings and panels; Gardner, Holmes & Co., 183 Canal street, New York.

Wooden butter plates.

Set of butter, picnic, and lunch plates; three-ply plaques, for decorative purposes; card-receivers, ornamental brackets, &c., from Smith & Stevens Manufacturing Company, Fulton street, New York.

The butter and other thin plates are made from sweet-gum, beech, birch, and maple, principally, obtained in North Carolina, Delaware, New York, and Vermont. The three-ply plaques, for decorating, are made from sweet-gum, white holly, maple, and walnut, obtained from the same States. Some of these are fashioned into card receivers, &c., as above.

The thin plates are made from veneers one-twentieth of an inch thick, cut into squares of the required size. When dried sufficiently they are pressed between hollow dies (eight or ten at a time) heated with live steam, the dies having circular knives fixed to cut the veneer plate or plaque; it is shaped and cut by the same movement of the lever either by hand or power. When taken from the press they are ready for use.

The three-ply plate or plaque is made from the thin single-ply and glued together, crossing the grain to prevent splitting or warping; pressed between "cauls" when glued until the glue is dry, then turned in a lathe, polished and stained if desired, ready for the artist's brush or other ornamentation.

There are various forms of wood-veneer butter and lard receptacles, though all are made in the same manner. A manufacturer in Ohio makes an oval form from elm lumber; others are square, tin being used in combination to strengthen the edges, while a very common form is lapped at the ends and held secure by a couple of tacks. One firm reports 100,000,000 plates per year as the product of their mills, and there are a dozen other establishments engaged in the manufacture of one form or another of these cheap and useful articles.

Grape and fruit boxes.

The manufacture of grape and other fruit boxes and baskets is a large industry, using many hundred thousand feet of lumber. The details of manufacture are so similar, however, to the above, in preparation of the lumber, that they are omitted. Bass-wood is chiefly used, though the other woods are sometimes substituted.

Excelsior.

Excelsior from white-pine wood, in the rough and manufactured; Grand Rapids Excelsior Company, Grand Rapids, Mich.

Another collection from poplar lumber; both of prepared material, and samples of wood used; Boston Excelsior Company, Boston, Mass.

Spruce and poplar excelsior; L. Murray, Hinesbury, Vt.

There are a dozen different kinds of machines in use for reducing lumber to the form of fine shavings known as "Excelsior." After cutting the lumber to right lengths and properly seasoning it, it is run through the machine, which practically cuts it first into thin ribbons, and then in threads of fiber, by means of closely-set parallel cutters. Second-growth timber and clean body-wood is usually employed in the manufacture.

Boxes, packing, &c.

"Lock-corner" boxes for confectionery, &c., in white pine; O. R. Wiswall, Marlborough, N. H.

Packing-boxes in cypress, from Henry Busch, 246 Commercial street, New Orleans, La.

Cigar-boxes, imitation of Spanish cedar, from white wood; Thomas Beagle & Son, 448 York avenue, Philadelphia.

Tobacco-boxes, for packing plug-tobacco, manufactured from sycamore and oak; Frost's Detroit Lumber and Woodenware Works. Sycamore tobacco-packing boxes, also; from Dusterburg, Meyer & Co., 82 East Second street, Cincinnati, Ohio.

In the New England States lock-corner boxes are commonly made of second-growth pine, and are usually ¼-inch lumber, dove-tailed by machinery, fitted together, and held by glue, the covers made to slide in grooves cut into the sides and one end. A "lock-corner" box passes through nine hands or machines from lumber to finished article, no steaming or kiln-drying being necessary, as the wood is air-dried in sheds. Cost of labor about one-half total cost. In addition to pine, as stated above, poplar, bass-wood, spruce, and fir are used for this purpose. The packing-box industry in the New England States alone is enormous.

V.—USES OF WOODS IN ARTICLES FOR MAN'S PHYSICAL COMFORT OR LUXURY.

The articles classed in this group come mainly under the head of furniture, including that manufactured for office, church, or school, as well as the household. Nearly all the best-known varieties of native woods (and a number of foreign kinds) find employment in the manufacture of these articles, by far the larger portion consumed being the higher grades of what might be termed fancy hard woods. But the softer woods, such as pine, poplar, and similar kinds, are also used largely, either in combination or alone as in cheaper makes of house furniture that receive paint as a finish.

A.—HOUSE FURNISHING AND DECORATION: Tables, chairs, etageres, hall-racks, and "parlor frames"; bedsteads, cribs, and cradles; bureaus, washstands, wardrobes, &c.; sideboards, buffets, &c.; book-cases, desks, and cabinets; bric-a-brac, decorative easels, curtain-poles, picture-frames, screen-frames, brackets, &c. The principal woods employed are ash, beech, birch, bass-wood, cherry, chestnut, elm, gum, hemlock, maple, oak, pine, sycamore, walnut, and whitewood.

B.—DOMESTIC ECONOMY: Woodenware and kitchen utensils, such as bowls or trays, rolling-pins, mauls or mashers, spoons, ladles, butter-molds, bread-boards, &c.; appurtenances of the laundry, as clothes-wringers, washing-machines, and mangles (birch, maple, and pine chiefly), clothes-pins (beech, birch, and white maple), clothes frames and driers (the same, with bass), washboards, tubs, and pails (see cooperage); mop-sticks, brooms, and carpet-sweepers, step-ladders, snow-shovels, and miscellaneous objects; refrigerators (the last in pine, spruce, walnut, ash, elm, bass, cherry, and whitewood).

A.—HOUSE FURNISHING AND DECORATION.

Chairs.

Cane-seat chair, in white oak, red oak, black walnut, red birch, hard maple, white birch, cherry, and swamp oak, from Bodenstein & Kuemmele, 1342 North Front street, Philadelphia, Pa.

Music-stand.

One oak folding chair, and parts of other chairs in birch, maple, and black walnut; New Haven Folding-Chair Company, New Haven, Conn.

Chair exhibited from G. Henshaw, Elm and Canal streets, Cincinnati, Ohio.

Beautifully carved hall-chair, "Argosy," with sail, oars, and other nautical emblems; Bruschke & Ricke, Chicago, Ill.

Carved music-stand in cherry, from F. Wenter, 109 West Fourteenth street, Chicago, Ill.

Furniture.

Pine bureau and washstand, from George A. Brooks, Baldwinsville, Mass.

While we are apt to suppose that only a few kinds of wood are used in the manufacture of furniture, such as walnut, cherry, ash, oak, pine, &c., nevertheless a score of different woods are regularly used by the furniture manufacturer. In "parlor frames," chair-stock, and general furniture woodwork there are used, white ash, white oak, cherry, elm, birch, beech, chestnut, maple of several varieties, black walnut, sycamore, bass-wood, whitewood or poplar, pine, spruce, and hemlock.

The furniture industry, with its five thousand and more establishments, is a large consumer of lumber, the value of materials alone in a single year amounting to $35,000,000. Of this sum, perhaps 8 or 9 per cent. represents the manufacture of chairs alone, as there are nearly 400 such establishments turning out every grade of chairs, from a camp-stool to a "parlor frame."

A factory consuming three-quarters of a million feet of lumber in a year, and engaged in manufacturing the better class of furniture, such as hall suits, parlor frames, &c., will require in its plant about fifty machines for different uses, as rip and cross-cut saws, band and scroll saws, jointers, sand-paper machines, turning-lathes, molding and shaping machines, &c. Then, as the lumber must be thoroughly seasoned, there must be dry-kilns, besides storage sheds for air-drying, so that capital of $50,000 to $250,000 may be invested in the industry. In the better class of manufactures the proportion of labor expended in the various stages usually runs up to nearly one-half of the value of products. That is, a pay-roll of $50,000 is necessitated in the producing of $100,000 worth of furniture. In the finer grades of furniture some foreign wood is used, chiefly mahogany, though walnut for certain uses may be almost as valuable at present scarcity.

All qualities of lumber are used in this manufacture, the majority of factories buying in the plank cut to sizes required. Very few concerns reduce from the log. The furniture industry is divided into specialties as in the manufacture of other products. There are a dozen or more different kinds of chair-factories; school furniture is another specialty; bedstead manufacture another, a score of factories turning out as many

different forms and many of them patented. There are a large number of desk manufactories, the "roll-top" desk alone being made in nearly every Northern State. A firm in the State of New York that turns out over 2,000 desks a year, with a quarter as many office-chairs, employs 150 men, and requires a plant of over forty machines, besides two kilns, and all the machines are kept at work. Over 600,000 feet of lumber, chiefly cherry, oak, white-ash, black walnut, pine, and poplar are consumed in the year, about 20 per cent. only being wasted in manufacture. Chamber suits, parlor and hall suits, wardrobes, extension and other tables, lounges and sofa-beds, cribs and cradles are all made as separate specialties, some concerns making several, but very few establishments manufacturing a general line of all kinds of furniture. Then there are large establishments where no finished furniture is produced, but that get out furniture and chair stock. The dowel manufacturers furnish large quantities of this kind of product to the chair manufacturer, and even such smaller specialties are reported as extension table slides, turned legs, and bent stock, also used in chair manufacture.

In getting out sofa and chair frames, the rough boards or planks go through a planer; then to the markers, they designing according to pattern with pencil-marks the forms of pieces to be cut out; then the board or plank goes through the hands of men who attend to swing, rip, band, and jig saws; then the pieces go to turners, and to molding and sand-paper machines, wood carvers, &c., until all are properly prepared. In some concerns, as chair factories, the lumber, after having been sawed into irregular pieces, is taken to the kilns, to be thoroughly seasoned before fitting together. When the pieces are formed to the different shapes of the furniture for which designed, the cabinet-makers receive the single pieces, fit them together, and finish the whole frame for market; that is, the cabinet-maker receives those pieces which belong to the article he is making; for instance, all the material for two or four hundred chairs of same pattern and size, or twenty-five to fifty sofa frames of same pattern; and by this division of labor the low price of manufactured goods is explained. Each piece of wood may pass through a dozen hands and as many machines before going to the finisher; in fact, considerable furniture is never finished (stained, oiled, varnished, &c.,) at the factory, but sold as it leaves the sand-paperer, to be finished as desired by the retailer. As to parts of wood employed, some use the entire tree, while others reject the heart and sap wood, dependent upon kind of manufacture.

Moldings (picture).

A complete series of picture-moldings in spruce, butternut, locust, white birch, hickory, poplar or whitewood, bass-wood, elm, cedar, maple, chestnut, cypress, white pine, white oak, white ash, California redwood, dogwood, cherry, hemlock, white holly, sycamore, black walnut, pecan, and yellow pine, from Hall & Garrison, 1124 Washington avenue, Philadelphia, Pa.

Venetian blinds.

One blind, in white ash, cherry, black walnut, and hard maple; F. H. Gile, Boston, Mass.

Embossed ornaments.

Set of compressed wooden ornaments, in a large variety of woods, donated by Albert Komp, New York City. These are used for decorating or ornamenting fancy cabinet work, furniture, &c.

B.—Domestic economy.

Clock-cases.

Clock-cases in oak, ash, chestnut, and walnut; New Haven Clock Company, New Haven, Conn.

Clothes-wringers.

Clothes wringers, mangle, &c., white ash and birch; Metropolitan Manufacturing Company, Middlefield, Conn.

This company also manufactures other goods, spring mattresses, &c., though not represented. In the manufacture of clothes-wringers the wood frames are constructed of clean red birch and hard maple. Washing-machines, clear Michigan white pine; mangles, pepperidge, or gum for the rods, and sometimes maple; mop-wringers, ash for rods. A New York manufacturer states that lumber is usually seasoned three years.

Clothes-pins.

Samples in various stages of manufacture, from the Saratoga Clothes Pin Factory, Northville, Fulton County, New York. These are made wholly of white ash.

Other manufacturers use various woods, such as beech, white and black birch, and maple, nearly the entire tree from the butt to parts of the tree at over 4 inches in diameter. Log lumber, however, gives a better class of clothes-pins. In manufacture the log after being brought to the factory is cut into lengths 31 inches by circular cut-off saw; then to a bolting saw and cut into bolts the proper thickness; then to a gang of saws cutting them into sticks. They are then placed on a revolving drum, which carries them to gang cut off saw, which cuts them to the exact length of the pin; then they go by elevators to the turners, where they are placed in a shoe, the turner working automatically; they are turned to the proper shape, and from there go to the slotting-machine, are there placed by the operator in troughs, the machine picking them up and slotting them; they are then placed in a revolve-pipe drier, going thence to the polishing cylinder, then to the packer. Each pin passes though eight hands.

Another manufacturer states that after preparing the little blocks of wood 5½ inches long, they are placed on an endless belt which feeds the blocks automatically into the lathe. As the lathe is turned the pin is taken automatically from the spindle, and placed on a turn-table and carried around to a circular saw which whittles out the slot in the pin. It is then finished and thrown out of the turn-table by the same appliance that puts the pins in the table. Falling they are caught in a basket or barrel, and are then taken to the dry-house for twelve to twenty-four hours, or until dry. They are then taken to the polishing cylinder or

rumbler, which holds 20 to 40 bushels; this is run at a slow speed, about thirty turns a minute for from twelve to twenty-four hours, and by simple friction and contact they become polished. In some manufactories the pins are dried and polished in a steam cylinder within another cylinder, having hot steam around all sides, except man-hole. They are next taken to the packing room, the packing being done by boys and girls, at about 1 cent a box of five gross, and expert hands have packed one hundred boxes in ten hours. While as a rule, makers use no coloring or staining, some blanch their pins before polishing. White birch makes the whitest and most salable goods. A single plant consists of board saw, gang splitter, gang chunker, turning lathe, drying-house and polisher; the value has been as high as $12,000 per set, now less than one-half. The cost of lumber is about one-third of value of pins.

Clothes-dryers and towel-racks.

Improved (bracket) clothes dryer manufactured from beech and birch. Three arm swinging towel-racks. Donated by C. A. Foster & Co., Fitchburg, Mass.

Towel-rolls, A. G. & J. C. Bemis, East Jaffrey, N. H. From cherry, whitewood, and black walnut. The process of manufacture is exceedingly simple.

Baskets.

Willow baskets were received from C. Goebert & Son, 56 North Second Street, Philadelphia, Pa.

Bread-boards.

Carved board for table use in white birch, A. J. and J. E. Bemis, East Jaffrey, N. H.

Matches.

Friction matches. Pine blocks in the rough, match-splints (the intermediate processes not illustrated) finished matches in variety. From the Diamond Match Company, West Haven, Conn.

A similar series of card matches were donated by the Boston Match Company, Boston, Mass.

It was impossible to obtain any information or statistics relative to this industry, as the different manufacturers jealously guard every process of manufacture. Michigan and Canada white pine, however, is used in this industry, the consumption running up into the millions of feet annually. When one extensive establishment reports a consumption of two to four millions of feet, we can form some faint idea of what a dozen will consume.

Step-ladders.

Specimen of step-ladders, out-of-doors clothes-dryers, and similar manufactures were contributed by Fellows & Day, 139 North Sixth street, Philadelphia. Woods used in their construction are oak, white ash, and basswood. Step-ladders are also made of pine and spruce.

Skewers.

Two bundles of machine-made hickory skewers, two sizes, were added to the collection by purchase. There are several skewer manufactories in the country, but neither replies nor specimens could be obtained from them.

Sweepers.

Crown automatic carpet-sweepers from black walnut lumber, donated by the United States Truck Company, Detroit, Mich. Carpet-sweepers are also made in all varieties of furniture woods.

Toothpicks.

A collection of toothpicks, in basswood, was obtained by purchase. They are manufactured by machinery at comparatively trifling cost.

Washing-machines.

The Doty Washing-Machine Company, of Chicago, Ill., donated one machine made of pine wood chiefly.

Butter-molds.

These are manufactured from hard maple, first turned to size and shape, and afterwards carved according to fancy.

Rolling-pins, potato-mashers, &c.

All these manufactures are turned from hard or soft maple, birch, or other close-grained woods; it only being necessary to have the lumber well seasoned and free from knots or checks. Good white young growth is considered best for the purpose.

Trays and bowls.

A series of bowls were received from North Carolina (?), but were not labeled, and so cannot be properly catalogued.

Wooden bowls are made of cottonwood, elm, maple, and sycamore lumber principally, the best of the sawed timber being selected, clear and free from knots.

In manufacturing bowls the logs are cross cut into lengths equal to the diameter of the log. The cut is split into two pieces, cleaving out a bolt through the center, about 3 inches thick, to get rid of the heart wood. The bowl-blocks are then faced by a broad-ax and a hole bored in the center; then it is put into the end of a mandril, which draws it on and against a collar; it is then whirled around by shaft, and again faced by a facing-tool in the hands of the turner; next, the turner sets into position the largest crane and circle that the block requires. The outside portion of the block is then turned off by means of the quarter circle. The timber from the circumference to near the center and the part that falls off is called the scull. The back turner then turns the bottom, back, and rim of the block, which is the outside and bottom side of the bowl; this makes the largest size. The face-turner then sets into position the next smaller-sized circle, which enters the timber as before, thus cutting off the first bowl. The process is repeated until the block is all used up.

One manufacturer estimates thirty factories engaged in this industry, with an invested capital of $300,000, which is probably a high estimate.

VI.—USES OF WOODS IN ARTICLES FOR EDUCATION, CULTURE, OR RECREATION.

A far larger group than the preceding, it represents (with some notable exceptions) a large number of smaller or less important industries, although employing as great a range of material in manufacture. Pianos and organs, as far as their cases are concerned might be classed

in the preceding group, but for the fact that their interior wood parts make them far more than mere pieces of house furnishing.

A.—SCHOOL APPARATUS: Globes, object forms, and drawing models; globe frames, in ash, beech, basswood, chestnut, birch, oak, maple, and black walnut; drawing boards, T-squares, rules; pencils and pen-holders; Kindergarten materials in wood; blackboards and pointers, map-rolls, &c.

B.—ARTISTS' MATERIALS: Sketching stools, easels, palettes (hard and soft woods), panels; cherry, holly, and firm-grained woods; maul-sticks, brush handles, stretchers, drawing boards, &c. Charcoal from willow is also used, though not from native woods.

C.—MUSICAL INSTRUMENTS: Pianos and organs, (interior parts in maple, spruce, sycamore, ash, pine, whitewood, &c.; cases of fancy furniture woods); violins (spruce, maple, and sycamore); banjos and similar instruments, drums (beech, birch, maple, and ash).

D.—GAMES AND AMUSEMENTS: Lawn-tennis racquets, croquet balls and mallets, base-ball bats, polo sticks, Indian-clubs and dumb-bells, checkers and chessmen, roulette boards, bagatelle and billiard tables, pitch and ring, and similar hoop games, employing nearly the whole range of available white woods.

E.—TOYS AND CHILDREN'S GAMES: Building and toy blocks, puzzle-blocks, carved and familiar object toys, rolling hoops, toy carriages, wagons and sleds.

A.—SCHOOL APPARATUS.

Object forms.

Under this head may be included object forms, geometrical solids, cubical blocks (to illustrate cube root), &c. These are manufactured from whitewood, beech, maple, bass, chestnut, oak, black walnut, and some other woods.

Among other school aids may be mentioned primary drawing models, as the cone, cylinder, double cone, spool, and prisms, in hard woods. Ellipsograph in maple. Primary counting blocks, rules, &c. The kindergarten "gifts," in various woods, should also be enumerated here; sphere, cylinder and cube; rock-maple cubes composed of eight, twenty-one, and twenty-four smaller cubes and blocks. Geometrical forms in light and dark woods. Sticks for stick laying, plain and colored. Hardwood slats for plaiting work tiles, with pegs and holes for forming lines, angles, and geometric forms, &c.

Globes and globe mountings.

These are made of various hard woods, such as cherry, ash, chestnut, &c.

Drawing-boards.

Drawing-boards in white wood, Keuffel & Esser, New York City.

Drawing instruments.

These are T-squares, rules, circles, triangles, and similar goods. None represented. All hard woods, though most commonly of maple, cherry, oak, or mahogany.

Lead pencils.

One large case of pencils, illustrating manufacture from first to last (log, plank, slab, strip, pencil), from the American Lead Pencil Company, New York.

These are manufactured chiefly from cedar derived from the west coast of Florida, and received in logs measuring on an average 12 inches square and 12 feet long. The method of constructing a pencil is as fol-

lows: The wood is cut into boards of about six widths of pencils and half the thickness of a lead pencil, dried by steam for about four weeks, grooved semicircularly (two boards, one for tops and one for bottoms) to fit around leads. These six-width slats are smeared with glue, the lead laid in the half grooves of one slab, and the other (bearing the other groove) placed over it. The two slabs are pressed together and left to dry, after which each pair of slabs thus glued together and containing six pencils is divided by a shaping machine into single pencils, then colored and finished. The "lead" is principally imported from Bohemia, is washed, mixed with clay to give it tenacity, squeezed through dies, macaroni-like, and burnt.

Regarding the supply of Florida cedar for this purpose, Mr. Curtiss says:

The favorite variety of red cedar, of tall straight growth, is becoming scarce, but there remains a large quantity of quality sufficiently good for pencils in nearly all sections of the State growth of a line drawn from Cape Canaveral to the north end of Charlotte Harbor. There is no red cedar in Southern Florida, the Dixon mill at Tampa having exhausted the supply within reach of that place; but new mills have been established near Webster, in Sumter County, and at the head of Crystal River, at present the best source of supply.

Mr. Henry D. Caruse, of the American Lead Pencil Company, makes the following interesting statements:

Because of lack of proper and adequate vigilance, many young trees are cut down, principally by trespassers, and used for inferior purposes (fence posts, &c.), consequently yielding a far less revenue to the country than if they had been permitted to attain their full growth, and then be offered in the markets for the arts and manufactures.

The present practice will eventually cause the extinction of this cedar. No tree less than 18 inches in diameter at the base of the trunk ought to be cut down. Even now Florida cedar is comparatively scarce, and recourse has been had to Alabama cedar, which is an inferior cedar, being more knotty, harder, and more difficult to free it of the oil than the Florida cedar.

The home consumption of cedar for pencils only cannot be less, at present, than 200,000 cubic feet, and in six months hence, when this company's new factory and machinery is ready, when we expect to turn out about 2,000 gross of pencils a day, the home demand will be about 300,000 cubic feet per annum. If to this be added an export demand of an equal quantity to the domestic consumption, as also what may be used for coffins, furniture, veneers, &c., the value involved is of no small magnitude. The lack of cedar would throw idle an invested capital of at least $5,000,000.

As the softness and aroma of the Florida cedar depends considerably, in the writer's belief, upon the swampy condition of the soil wherein it grows, care should be used that the cutting be not confined to any particular section, as by denuding the ground of the trees, not only the fall of rain would be less in that section, but the earth, being less sheltered, would become dry and sterile.

Pen-holders.

Wooden pen-holders in bass-wood, American Lead Pencil Company, New York City

B.—ARTISTS' MATERIALS.

Easels.

One cherry folding sketch-easel, from Keuffel & Esser, New York City.

These are all made in maple and other woods.

Common tripod easels, in pine and black walnut.

Studio easels (upright), mahogany, cherry, walnut, and other hard woods.

Palettes.

Square, oval, and folding palettes, in bird's-eye and plain maple, black walnut, and mahogany, Keuffel & Esser.

Maul-sticks.

In walnut and cherry, the latter jointed, with brass socket and ferrule, Keuffel & Esser.

Sketching-stool.

One folding sketching-stool, in maple, donated by Keuffel & Esser. These are made also in ash and other tough woods.

Canvas-stretcher.

Patent pine stretcher for mounting canvas for oil painting, Keuffel & Esser. These should be made from boards cut directly across grain, and will then be free from warping.

Miscellaneous.

Color boxes, most commonly made from tin, are sometimes made of wood, such as cherry, mahogany, or any hard variety. Brush-handles, when made in this country, are of red cedar, pine, or white wood; panels for painting, cherry, or any close-grained wood that has been perfectly seasoned.

C.—MUSICAL INSTRUMENTS.

Pianos and organs.

One large case of panels and parts, representing the manufacture of pianos and organs, was donated by B. Schoninger & Co., New Haven, Conn.

Although some twenty different woods are exhibited in this case, the principal woods used are pine, spruce, whitewood, chestnut, maple, bass-wood, white ash, and black walnut. The frames or bed timbers (of an upright piano) are made of ash, and other interior work of maple. The sounding-board is of spruce (see below), while the pine and whitewood appears in portions of case and unimportant parts. Cases and ornamental work, usually walnut and imported woods; in veneers, other woods are used in the interior parts.

In the Schoninger factory the black walnut is used both in the solid and in veneers, and now comes mostly from Tennessee and the adjoining States. The ash is from Indiana; whitewood, from the Western States; bass-wood, from Michigan; maple, from Northern New York; chestnut, from New England. Nearly all the wood used is from first-growth timber, and the desirable qualities are clean, straight-grained stock, easily worked, free from gum, and having good resonant qualities.

Piano sounding-boards.

Admirable samples representing the manufacture of spruce sounding-boards were donated by Alfred Dolge, Dolgeville, New York.

Lumber for sounding-boards is very carefully selected, and air-seasoned for about a year, with six weeks of subsequent kiln-drying in dry-house at a temperature of not over 120° F. This slow process of drying is necessary for all sounding-lumber. After the lumber is planed and edged it is carefully assorted, matched, and glued into boards of an average size of 4 by 5 feet. The entire board is generally planed three-eighths thick.

In this industry alone four concerns are engaged, employing about five hundred men and an invested capital of $200,000.

Mr. Dolge uses the best quality only of spruce logs, cut into quartered boards, 13 feet long, 4 to 8 inches wide, and five-eighths thick. The spruce is derived from Herkimer, Fulton, Lewis, and Hamilton Counties, in the Adirondack region of New York. In the Schoninger establishment the sounding-boards of both pianos and organs are made of three different kinds of wood, and glued together crosswise. This arrangement, it is claimed, prevents all cracking, shrinking, or swelling.

Violins.

Violins, and parts, donated by Charles F. Albert, 205 S. 9th street, Philadelphia.

This collection embraces violin and cello sound-posts of silver spruce; neck and sides of violin, curly maple; cello bridges of plain maple: bridges of sugar-maple; sides of curly sycamore. The process of manufacture, seasoning of lumber, &c., could not be obtained.

Banjos and tambourines.

Banjo and tambourine hoops, or rims. From beech, maple, and birch.

Logs sawn into planks, split in strips, planed, steamed, bent into shape, secured at laps, finished. All parts of the body of the tree are used that are free from knots, "curls," or other imperfections.

D.—Games and amusements.

Base-ball bats.

Series of base-ball bats in cherry, spruce, white ash, willow, and bass-wood. From Peck & Snyder, New York City.

The same, from H. Rademaker & Co., Grand Rapids, Mich. One set of bats in ash, maple, pine, and poplar. From A. G. Spalding & Bros.

Sawed to proper size, air and kiln-dried, turned on lathe, oiled or French-polished, painted, and branded.

Lawn-tennis racquets.

Racquet in white ash and California redwood. From Peck & Snyder.

In making a lawn-tennis racquet it is: First, sawed out of plank with a circular saw; second, planed with a surface-planer; third, steamed and bent; forth, kiln-dried; fifth; glued together; sixth; planed out of wind with an angle-planer; seventh, inside of rim cut on an irregular molder; eighth, handle glued and cut to shape on molder; ninth, sandpapered on wheel, and by hand-labor; tenth, holes bored for strings with machine; eleventh, French polished; twelfth, strung with gut string (lamb's), and then it is ready for market.

Polo mallet.

Sticks or mallets used in the game of polo, with horses, made from white ash. Peck & Snyder.

This is a small and narrow mallet-head into which is set, at at an acute angle, a long, slender handle. A "sling-stick" also accompanies the samples.

Horizontal bars.

Set of bars and trapeze in best white hickory, finished and polished. Peck & Snyder.

Croquet set.

Balls, mallets, and posts in various woods. H. Rademaker & Co., Grand Rapids, Mich., two sets. A. G. Spaulding & Bros., one set.

The balls are turned from thoroughly-seasoned rock-maple; mallets, rock-maple heads and white-ash handles, apple-wood sometimes being used instead of rock-maple; posts, ash. Second-growth lumber chiefly used.

Indian clubs.

Pair of highly polished rock-maple clubs. H. Rademaker & Co.

A second pair, from Peck & Snyder, New York.

Set of clubs in whitewood. A. G. Spalding & Bros.

Dumb-bells.

Set of hard-maple dumb-bells, from Peck & Snyder. These are made from second-growth lumber, thoroughly seasoned by air and kiln-drying. The dumb-bells were accompanied with set of wooden rings for light calisthenics.

Checker-men.

Maple checker-men, plain and colored. De Witte C. Lockwood, Derby, Conn.

Lumber sawn to bolts 18 inches long, and slightly larger than diameter of checkers; machine-turned and polished; sawn into blanks, thickness of checkers ($\frac{3}{8}$ of an inch), placed in revolving cylinders to polish and remove splinters and chips; run through embossing machine under powerful pressure, which stamps out and finishes the men. Stained, painted, sorted, and packed in boxes. Require about eight operations.

A cherry checker-board and set of checkers in maple were also presented by the Milton Bradley Company, Springfield, Mass.

Billiards.

Parts of billiard tables from the Brunswick-Balke-Collender Company, New York.

This series of illustrations of billiard-table manufacture includes one end rail of white oak, with black-walnut panels; one side of rail of white ash and oak, inlaid with panels of cherry root, blister walnut, ash burl, walnut burl, Kentucky wahoo, California redwood; also, one cue in white ash.

Miscellaneous.

Pitch-a-ring, magic hooks, and ring games. Milton Bradley Company, Springfield, Mass.

The boxes are of chestnut, posts of maple, and hoops or rings of rattan.

E.—Children's toys.

Blocks.

Building-blocks in bass-wood. Milton Bradley Company, Springfield, Mass.

The Milton Bradley Company also manufacture a large series of puzzle-blocks, letter-blocks, and similar toys, chiefly bass-wood and cherry. Bass is well adapted to toy manufacture, because it contains no pitch, and therefore glues well, works easily, and the absence of pitch avoids soiling paper that is pasted on blocks.

Toy horses and carts.

Small horses and carts, the former of bass-wood and the latter of elm, birch, and bass-wood. A. B. Ruggles, Birmingham, Conn.

These are made from the best quality of lumber, the bass-wood obtained from Michigan, although nearly as good quality can be obtained in New York and other States. The other woods are obtained in Connecticut.

The plank is first planed, then rough-shaped by band-sawing, carved by hand, sand papered on wheels and belts, glued and nailed, the different sections together, painted, trimmed, and packed. Machines in use, planer, band and table saws, swing-saws, variety and common lathes, borers, sand-wheels, belts, &c. Value of plant, about $10,000. Proportionate cost of labor to full cost of production, about 66⅔ per cent. The bass-wood is peculiarly adapted for making toy horses or other articles where small portions or angles stand out (like the ears and legs of horses), on account of its tenacity or toughness, and at the same time light weight and easy working quality. No special treatment required. Each article is handled about twenty times before ready for shipment.

The plank used for horses is cut up in short lengths for convenience, then taken to the band-saw and sawed into rough outline shape, thence to the carver, then to sand-wheel for smoothing off ready for painting. The hubs to wheels are turned in variety lathe, which bores and shapes them at one operation, from square stick, at a rapid rate.

Toy drums.

Toy drums in bass-wood, maple, and cherry.

In making a toy drum the log is blocked off the length that is required for the circumference of the drum, put into a revolving cutting-machine, which reduces to the thickness required for the shell of the drum, then to a scraping-machine, which takes the ends to a beveled joint ready for steaming, then taken to the bender, where several sizes are bent in one nest, dried, laps glued, then smoothed on a small wheel or belt, then taken to the paint-room, where ornamented, varnished ready for the heads. The heads tucked round a small hoop to hold them in place, snares put on, then drum put into a press, where the hoops are pressed on, cord and tightening straps put in place, all ready for packing-room, then put into cases that hold from four to twelve dozen each. At least fifteen distinct operations from rough lumber to finished drum.

Toy tables and chairs.

Toy furniture, from the Converse Toy and Woodenware Company, Winchendon, Mass. The firm also donated examples of drawing and blackboards for children's use.

Bow-guns.

A specimen of bow-gun in white-wood, from Peck & Snyder, New York City.

One toy spring-gun in bass-wood. Milton Bradley Company, Springfield, Mass.

Toy express-wagons, &c.

Specimens of manufacture from Tricycle Manufacturing Company, Springfield, Ohio.

VII.—MISCELLANEOUS USES.

In this provisional group may be placed such wood manufactures as cannot properly be classed with any of the preceding, such as gun-stocks, wooden shoes, artificial limbs, crutches, canes, surgical appliances in wood, &c.

Gun-stocks.

The Whitney Arms Company, of New Haven, Conn., presented a series illustrating the manufacture of gun-stocks from the rough-sawn plank to the finished stock.

E. Remington & Sons, Ilion, N. Y., who were asked to make some statements regarding this industry, reply that the best walnut for gun stocks comes from Ohio, Missouri, and Tennessee, being received in the form of second growth 1 and 2 inch plank and one-sixteenth veneer. The firm used over 1,000,000 feet of walnut, cherry, oak, bass-wood, ash, and pine per year, one-third being walnut, the other woods being used for cabinet-work and boxing-lumber.

The operations upon a plain gun-stock for the Springfield rifle may be enumerated as follows: Rough sawing; cutting off butt and tip ends; marking four points in butt end and one in tip end for fastening in turning-lathe; turning tip and butt; spotting (or by means of a circular-saw gang marking places on each side of butt and tip, and several on one side of the stock between the head and tip, as a guide for additional operations); cutting barrel-groove; cutting for receiver and tang and tenon of breech-screw; finish cutting barrel-groove; squaring tenon mortise; planing sides and edges of stock to a former; sawing off butt and tip to gauge length; cutting butt-plate curve; bedding butt-plate tang; boring and tapping for butt-plate screws; bedding for lock-plate; boring for tang of sear and for bridle and sear screws; cutting recesses for main-spring bridle, tumbler, and sear-spring; countersinking for head of bridle screws; bedding for guard-plate; boring for guard bow-nuts and trigger-stud; cutting mortise for blade of trigger; boring hole for guard, tang, and side screws, and counterboring for side screw-washers; finish cutting top, upper, and lower bands, and between bands, and forming shoulders for bands, and shoulders and tenon for tip; finish turning from heel of butt to head and from head to lower band; bedding for ramrod-groove and stop and forming holes for studs; cutting recesses for the band-spring and boring holes for their tangs; boring ramrod-groove; cutting barrel-groove for receiver; cutting groove for arm of hinge-pin; boring hole for tip-screw; finishing with hand-shaves, scrapers, and sand-paper and oiling with linseed oil. These last few hand operations require about five-eighths of the labor upon the stock, all the varied and curious cuts made by machinery requiring only three-eighths, which is a very forcible exhibit of the value of labor-saving machinery. The enumeration of the foregoing operations outlines a complete system of manufacture which has, since 1820, been gradually evolved from the whittling, boring, and chiseling by hand, which then constituted the single craft of stocking.—[Manufacture of fire-arms, Tenth Census Reports.

The following is given concerning the processes of manufacture by the Remington Company:

Two-inch plank is first cut up into the rough-shape gun-stocks, and each stock is profiled, that is brought down to a uniform rough state, when it is placed in the butt-plate milling-machine, and the end of the stock prepared for putting on the butt plate. Having thus got an exact starting point, the stock is sawn off to the required length, and the opening is made for letting in the system or frame, after which the

long groove in which the barrel lies is cut and edges of it beveled off. The stock is then turned to the required shape, and the tip-iron is put in place, which finishes the machining part of the manufacture of the gun-stock. The remainder of the work is done entirely by hand and with the use of the usual tools. The entire time required from the moment the rough plank goes under the saw to the completion of the machining is about forty minutes.

Artificial limbs.

One sample willow lumber, with leg carved in relief; artificial limbs in parts and complete, from A. A. Marks, 691 Broadway, New York.

Mr. Marks states that artificial limbs are also made from bass-wood. Most of the wood used comes from Fairfield County, Connecticut, only thrifty, large trees being selected, the trunks alone being used. The wood is secured in winter. Bass-wood from Ohio and willow grown in New York State have also been used, but they find no superiority over the Connecticut-grown lumber. From the irregular shapes and hollow forms of limbs the waste often amounts to 90 per cent., the lumber costing from $150 to $200 per thousand feet. It comes to the factory in blocks 4 to 8 inches square, and from 1 to 4 feet long, bored out in the center when green, and seasoned for three years. It is also stated that American willow and bass-wood are not excelled for this purpose by any of the many foreign woods that have been experimented with. The different processes of manufacture are interesting. The tree is cut into lengths of from 1 to 4 feet, split into square pieces of from 4 to 8 inches, dressed on a circular saw, bored the entire length with 1 or 1½ inch auger, allowed to season in a dark, dry place for from two to three years. Carved into shape, hollowed out to a thickness, smoothed outside and inside, hooped to give it additional strength, covered outside with buckskin, a water-proof coating applied to the covering. Inside of leg is smoothed and polished. Feet are made by carving a block of willow wood into the shape of a small last of about two-thirds the diameter of the natural foot; about this sponge rubber is vulcanized, alternated by layers of canvas. Some of the wood-work is done by grinding and sand-papering machines, otherwise the work is done by hand. The leg will pass through at least a dozen hands before finished.

There are about fifty manufactories of artificial limbs in the United States; capital not estimated.

Wooden shoes or sabots.

A number of pairs of wooden shoes were presented by Felix Marston & Blair, 55 South Water street, Chicago. No information could be obtained as to woods employed or processes of manufacture.

Crutches.

Several pair of crutches in white ash and maple, from Nathaniel Wilton, Franklin, N. H.

Mr. Wilton states that of native woods cherry and birch are also used, and of foreign woods, lancewood and rosewood. The native woods are second-growth lumber, obtained mainly in New Hampshire and Vermont.

First saw the lumber into strips five-eighths by seven-eighths; these

are planed, and some kinds steamed and bent in molds; a spoke-rounder is used to round them, after which they are finished on a sand-belt, two pieces glued together at bottom; nickel-plated trimmings put on, with rosewood handles and leather tops. The cheapest kinds are turned in a lathe, split down within 10 inches of end, a rivet put through at end of split handle and wood top put on.

Messrs. Augustus Beckel & Son, 30 North Sixth street, Philadelphia, presented crutches made of white birch, white ash, and hard maple.

Umbrella-sticks and canes.

A large case was presented by Montgomery Ford, 1028 New Market street, Philadelphia, Pa.

Canes are shown in ash (with and without bark), Florida orange, peg-wood, oak, tea-berry, hard maple, swamp huckleberry, birch, iron-wood, and dogwood. Umbrella-sticks were shown as follows, the first mention referring to shank, the second to handle: Maple, maple; maple, apple; maple, stramonium; birch, birch; maple, oak; maple, alder; maple, Florida orange; dogwood, dogwood.

Pine hair, &c.

Samples of manufactures from the long-leafed pine (*Pinus australis*) of North Carolina. Presented by the Acme Manufacturing Company, of Wilmington.

Raw material; one sapling (trees attain a height of from 60 to 100 feet); one bag of needles. Manufactured products; three grades, A, B, and C.

Pine hair for upholstering purposes, being clean and sweet, and so prepared as to preserve the balsamic odor; one bag, grade D, substitute for hair in plastering; one sample real pine hair; one bag of pine wool; one bottle pine burr oil; one bag pine dust (as a fertilizer, said to contain a high percentage of ammonia), and one bottle of pine oil.

The pine wool is claimed to be the nearest approach to natural wool ever made from vegetable fiber, and it is intended for spinning and weaving into mattings and carpets. "It takes and retains dyes without a mordant." The manufacturers also claim that the pine oil is a valuable medicine and antiseptic. "The well-known properties of the needles of the long-leaf pine, as containing carbolic acid, tannin, and creosote, are here preserved with a sweet, balsamic odor." The manufactured products are said to be "vermin proof."

Chemical products.

Into this group has been classed a variety of manufactures, obtained wholly or in part by chemical treatment of wood, and including charcoal, wood-pulp, bark extracts, and other products of wood that undergo at the same time certain mechanical manipulation.

Charcoal.

Samples of ordinary pit charcoal.

In reply to queries regarding the manufacture, Mr. S. L. Griffith, of Derby, Vt., gives the following interesting information:

Timber used is chiefly birch, beech, maple, spruce, and hemlock, the lower portion of the tree being used as lumber, and all remaining portions cut into cord-wood and subsequently burnt in charcoal pits. It requires twelve days to char the wood and six days to cool. A cord of dry hardwood yields 50 bushels (2,688 cubic inches each).

green hardwood, 42 bushels. Dry spruce and hemlock wood yields 75 bushels; green, 60 bushels. Margins are very small to day, as it costs 6¼ cents to make and deliver coal into cars, and sells for 6¾ to 7½ cents.

In a recent article in Outing on "The charcoal-burners of the Green Mountains," the following interesting statements are given:

The walls of the kilns are 12 inches thick and the kilns from 25 to 30 feet in diameter, 12 feet high to the crown, and about 7 feet crown, with a circular opening in the crown of 5 feet diameter. The only other opening (except the vents) is the door, which is closed by a heavy slab of No. 8 iron. The floor is of clay and well tamped, and the foundations are thoroughly grouted before the structure is commenced, as the kilns expand with the heat and contract while cooling. There are three tiers of vents or openings the size of a brick left in the walls for the purpose of drawing the fire back and forth—one hundred and twenty vents to each kiln—and they are called "waist, knee, and ankle vents."

In preparing a kiln for firing, a foundation of logs is first laid upon and covering the floor, except a fire arch from the door to the center. Then the logs are piled as above described, until the kiln is full, when the center is filled with kindling, and the pile is ready for firing. A rag saturated with kerosene is attached to a pole, and, being lighted, is thrust under the fire arch to the center, igniting the soft kindling; the door is closed and hermetically sealed; the thimble, or iron circular plate, placed over the opening at the top, and for ten or twelve days the process of charring goes on, being regulated by the vents around the base of the kiln. It is necessary that the fire should begin at the top and burn downward, and for this purpose two openings are left in the thimble at the top, each of which is easily covered with a brick. These are left open or closed, as emergency requires, and the vents are opened as needed, to draw the fire downward through the pile. When the wood is sufficiently charred above these vents, which is ascertained by the smell of the smoke, or by thrusting a bar into the vents, to feel whether it is wood or coal, the knee, or middle row of vents, and the ankle vents, are opened in succession, although the lower vents, as a general thing, are not opened, the collier preferring to burn the lower tier of logs in another kiln rather than run the risk of over-firing.

The kilns have a northern exposure, and when the wind is from that direction great care is necessary not to burn too fast. When it is from other quarters the burning is more regular. Sometimes a sink occurs, which means that the fire is drawn down too rapidly, leaving a middle portion uncharred. This is to be avoided, and can only occur through the carelessness of the collier. After the charring operation is complete the vents are stopped, the body of the kiln is thoroughly whitewashed, and the crown covered liberally with coal-tar, to make everything air-tight, and the kiln left for two days to cool off. It is then opened, and the coal can be taken out immediately. Thus it requires fourteen days at least to burn a kiln; two to fill, ten to burn, and six to cool. The secret of good coal, however, is to take time, and it is preferable to give it twelve days to char.

Wood-pulp.

Series of samples illustrating manufacture of wood-pulp, from the American Wood-Paper Company, Manyunk, Pa. Samples 1, 2, 3, poplar chips; 4, 5, and 6, unbleached paper pulp; 7, 8, and 9, bleached pulp; 10, unbleached paper; 11, bleached paper; 12 and 13, card-board and writing-paper. These samples represent the soda process of manufacture.

Samples from Herkimer Paper Company, Lyons Falls, N. Y.: 1, moist poplar pulp; 2, spruce pulp; 3, poplar wood; 4, poplar pulp, dry; 5, spruce wood; 6, spruce pulp, dry; 7, steamed spruce wood; 8, steamed spruce pulp, dry.

Pine, spruce, poplar, balsam-fir, and bass-wood are all reported as used in the manufacture of this product, and as a rule the best quality

that can be secured. It is cut into cord-wood, usually in the winter, though some manufacturers say all seasons of the year, and one in May to August, when the bark will slip easily.

A New York State manufacturer gives the following processes of manufacture:

We first cut up the wood in a machine (which cuts diagonally across the grain) after being thoroughly peeled and cleaned. Then put in upright boilers (6 by 22 feet) which hold two and one-fourth cords; then boil it in strong alkali twelve hours; then separate cellulose from liquor, and wash the former and then bleach white, and run over a paper-machine, and make it into rolls, for market. The liquor we take to evaporating furnaces and recover the alkali to the extent of about 83 per cent. We pass this stock through eight rooms or processes. Use 60 to 70 tons coal per day; employ 120 men at mill. The actual cost for labor in mill is about 15 per cent.

A Vermont manufacturer writes as follows:

We cut the log or stick in blocks on a circular saw, cut bark off with a barker (similar to a stave or shingle jointer) split it up and take out knots, and put it into a grinder which grinds off the fiber. It goes to a screen-plate which sifts out the slivers, and the rest goes to a wet press which takes the pulp up on a roll, from which it is taken off in sheets averaging one-eighth inch thick.

From a Massachusetts manufacturer:

Chipper to cut into chips one-fourth inch long, steel digester 7 feet diameter, 24 feet long, to disintegrate the fiber, by use of chemicals and 120 degrees steam. We use ordinary paper-beating engines to reduce pulp.

The following letter from Howard Lockwood, Esq., editor and publisher of the Paper Trade Journal, New York City, is of interest:

NEW YORK, *January* 22, 1885.

Mr. CHARLES RICHARDS DODGE:

DEAR SIR: I am in receipt of your favor of the 17th instant, and in answer to your question as to the number of factories in the country engaged in producing wood-pulp and wood-fiber, I send you by same mail the section of my Directory of Paper Trade for 1884. This will give you all the pulp-mills in operation and idle, and a full description of each. I have no statistics which will enable me to even approximately tell how much capital is invested in this particular branch of the paper industry.

According to tabulations made from this edition of my Directory, there was a producing capacity of chemical fiber in 1884 of 576,000 pounds daily, showing an increase over 1883 of 20½ per cent.; of ground wood-pulp there was a producing capacity of 795,550 pounds, showing an increase over 1883 of 25½ per cent. The above figures show the producing capacity of the mills, and, as a rule, should be considerably discounted, when considering the actual output; but, in view of the fact that these statistics do not include a large amount of fiber and pulp which are made at paper-mills in connection with the paper-making plant, and consumed on the spot, I should conclude that the capacity above named represented very fairly the actual production of these two products.

In reference to the question No. 16 of the inquiry circular, and bearing upon the forestry question, I would state that it takes a cord of wood of the kind used—poplar and spruce—to make 1,000 pounds of chemical fiber, and a cord of wood produces about 1,200 pounds of ground wood-pulp; therefore, you will see, by figuring on the basis of the above statistics, that it takes about 1,240 cords of wood to supply the mills of the country in producing their daily product; or, to produce a yearly output, will consume 369,000 cords of wood.

I would also call your attention to the fact that all of this wood, used for making fiber and pulp, has to be peeled and trimmed of all projecting knots, and in this way it represents a very large destruction of forest growth annually.

We have given considerable attention in this office to the question of the destruction of forest alongside of steams, and the effect of the same in diminishing water supply. I think beyond a doubt to this cause may be attributed the failure of many of our smaller streams in the Eastern States, and this whole question is one of vital importance to the country at large.

I remain, yours truly,

HOWARD LOCKWOOD.

The Directory to which reference is made shows a list of about 175 mills in the United States and Canada. Two mills are given in Louisiana which manufacture pulp from bagasse of sugar-cane, and one in Florida from palm fiber.

Rosin and turpentine.

Collection of pine products prepared and donated by W. G. Clarke, Chickasabogue, Ala.

Section of pine tree (showing boxes and scarifications).

Crude turpentine, from box.

Green turpentine (taken from face of tree at close of season).

Sprits of turpentine.

Rosin C, strained; rosin D, good strained; rosin E; rosin F; rosin G; rosin H; rosin I; rosin K (low pale); rosin M (pale); rosin N (extra pale); rosin W. G. (window glass); rosin W. W. (water white). Dry distillation of pine knots and light wood, specimens as follows from some source: Pine knots, light-wood splints, tar (ordinary process), charcoal (made in retorts), crude pixine, pixilic acid, refined pixine, oil of tar, navy pitch.

Miscellaneous products as follows: Rosin oil, rosin varnish, brewer's pitch, pine cones (natural state), pine cones dipped in rosin, pine leaves prepared for mattrasses.

The accompanying letter from Mr. Clark will explain the collection of pine products enumerated above:

CHICKASABOGUE, ALA., *May* 8, 1885.

CHARLES RICHARDS DODGE, Esq.:

DEAR SIR: Your favor of 4th instant is just to hand, and I hasten to reply. I return your circular sent, filled, as far as I can do so, with regard to the, manufacture of lumber at this point, but think it better to answer your special inquiry in this separate communication.

My exhibit at the New Orleans Exposition is comprised (or was so intended, but it is not arranged exactly as I intended) in three sections or divisions, the first representing the product from the ordinary distillation of the crude turpentine as gathered from the pitch-pine or turpentine tree; the second the products from destructive distillation of pine knots or light-wood; the third the products resulting from the combination of the products from the two processes mentioned and articles made from the leaves of the pine tree.

In the first section I showed sections of the pine as boxed and wounded or chipped, to stimulate the run of the sap, including specimens of one, two, three, and four years working, the latter having its long faces covered with gum turpentine or scrape, the accumulation of the latter part of the season, when the nights become cool and checked the flow of crude to the boxes. In this division I furnished specimens of the crude turpentine as taken from the boxes, showing the virgin dip, the old dip, and the gum turpentine or scrape, in separate jars. I also exhibited spirits of turpentine and the various grades of rosin from "C," the lowest grade I make, the "window-glass," the highest grade I manufacture. In the second division I supplied a bundle of pine knots, which are found scattered all through our pine woods, and, before my process was discovered, were left to rot and waste, except such as were

used for kindling-wood. I also sent a bundle of light wood or rich fat pine, cut in billets, as we prepare it for the retorts. We use the knots and split light wood indiscriminately in the retorts, and the richer the wood the more valuable is the product.

The wood, when prepared properly, is placed in iron baskets holding about half a cord each, which are let down into the iron retorts, the caps put on, and luted; then fire is started in the furnace and kept up until sufficient gas is produced, by which the firing may be continued, or until the process is completed. For this firing ordinary pine wood is preferable, although we frequently use knots or light wood. These are, however, objectionable, as they tend to fill up the flues and interfere with the draft. But to return to the exhibit: the products of this distillation are tar, charcoal (which is much heavier and richer than the kiln-burnt coal and will even answer for welding iron), crude pixine, pixilic acid, refined pixine, and oil of tar, which is pronounced superior to that article produced in the ordinary way.

In the third section I had navy pitch, rosin oil, rosin varnish, specimens of pine burrs in their natural form and also dipped in hot rosin (these were, of course, only as curiosities, not claiming any value); pine mast or seed, and specimens of vegetable hair or wool, made from the leaves of the pine and used for upholstering mattresses, &c. This last article I procured from North Carolina for the exhibit, and I do not know the secret of the preparation.

The special products of this destructive distillation (or retort processes) are comparatively new. Their valuable properties were discovered by myself and others who experimented with them, but they have stood the test of experience and are acknowledged to be very valuable for many purposes, especially deodorizers and disinfectants, for which purpose the pixine has no superior. I send you, as suggested, some printed circulars explaining the uses and character of the pixine and pixilic acid. The demand for the article is growing and its reputation extending, although it has not been advertised and no attempt has been made to attract special attention to its merits. A large portion of the acid now goes to waste, as it will not bear, in its liquid form, the exposure of distant transportation, but it is my design to enlarge the works and prepare to convert the acid into various articles of commercial value and large use. By chemical combinations I can make with it acetic acid and nearly all the acetates known to commerce or used by manufacturers. Indeed, the variety and extent of valuable products attainable under this process are truly wonderful, and not the least wonderful thing about it is that the basis of all is, in this section at least, waste material in most part absolutely worthless, gathered for this purpose, and therefore costs only the labor of gathering and conveying to the retorts.

With these works completed, as I desire, I could furnish acetate of lime at a cost which would defy foreign competition and, if the quantity were sufficient, stop the large importation altogether. The pixilic acid, which is only made from pine knots and fat light wood, differs from the ordinary pyroligneous acid in that it is much richer and heavier, contains larger proportions of tar and creosote, and is therefore a better disinfectant and preserver of wood.

Shingles or planks saturated in it are fire-proof, and I have used the acid with wonderful effect in extinguishing fires. Pixine, on the contrary, is very inflammable, but is not explosive. A notable characteristic of the charcoal is its dryness and freedom from dust; a lump of it may be taken up with white kid gloves without soiling them. But I fear I am becoming too prolix on this topic, and less I trespass too much upon your time and patience I will stop, subscribing myself,

Very respectfully, yours,

W. G. CLARK.

From the Report on Maufactures, Tenth Census, the following statements relative to the turpentine and rosin industry are taken:

The naval stores manufactured in the United States are principally produced from the resinous exudations of the long-leaved pine (*Pinus palustris*), and in small quanti-

ties from the loblolly pine (*Pinus teda*), and the slash pine (*Pinus cubensis*) of the Florida coast. The trees selected for "boxing" are usually from 12 to 18 inches in diameter, although trees with trunks only 8 inches through are now sometimes worked. A deep cut or "box" is made in the trunk of the tree by a cut slanting downward some 7 inches in depth and generally 12 inches above the ground, and met by a second cut started ten inches above the first and running down from the bark to meet it. In this manner a segment is removed from the trunk, and a triangular trough formed 4 inches deep and 4 inches wide at the top.

The boxes are cut early in November with a narrow-bladed ax specially manufactured for the purpose, and the trees are worked on an average during thirty-two weeks. As soon as the upper surface of the box ceases to exude freely it is "hacked" over and a fresh surface exposed, the dry resin adhering to the cut having been first carefully removed with a sharp, narrow steel scraper. The boxes, especially after the first season, are frequently hacked as often as once a week, and are thus gradually extended upward until upon trees which have been worked during a number of seasons the upper surface of the box is often 10 or 12 feet above the ground. For these long boxes the scraper is attached to a wooden handle, generally loaded with iron at the lower end to facilitate the operation of drawing down the resin. Once in four weeks, or often less frequently, the resin caught in the bottom of the box is removed into a bucket with a small sharpoval steel spade attached to a short wooden handle. The product of these "dippings," as this operation is called, is placed in barrels and transported to the distillery. The first season a turpentine orchard is worked boxes are usually dipped eight times, yielding an average of 300 barrels of turpentine to the crop. The second year the number of dippings is reduced to five, the product falling off to 150 barrels, while for the third season 100 barrels are considered a fair yield from three dippings. To this must be added the yield of the "scrapes," which for the first year is estimated, for one crop, at from 60 to 70 barrels of 280 pounds each, and for succeeding years at 100 barrels.

The following grades of turpentine are recognized in the trade: "Virgin dip" or "soft white gum turpentine," the product the first year the trees are worked; "yellow dip," the product the second and succeeding years, and becoming darker colored and less liquid every year; "scrape" or "hard turpentine," the product of the scrapings of the boxes.

Rosin is graded as follows: "W," window glass; "N," extra pale; "M," pale; "K," low pale; "Q," good No. 1; "H," No. 1; "G," low," No. 1; "F," good No. 2; "D," good strain; "C," strain; "B," common strain; "A," black.

Tar, produced by burning the dead wood and most resinous parts of the long-leaved pine in covered kilns, is graded as follows: "Rope yellow" or rope-makers' tar, the highest grade produced with a minimum of heat from the most resinous parts of the wood; "roang," or "ship smearing," the next running of the kiln; "black" or "thin," the lowest grade, made from inferior wood or the last running of the kiln, and therefore produced with the maximum of heat.

Miscellaneous.

Collections of J. A. Mathieu, Detroit, Mich. Case 1, three samples, oak, chestnut, and dogwood lumber. Case 2, five samples of charcoal from dogwood and chestnut. Case 3, two samples acetate of iron, black liquor, and two samples pyroligneous acid.

Collections of J. S. Young & Co., Hanover, Pa., and Baltimore, Md. Boston Dyewood and Chemical Company, selling agents:

Quercitron bark liquor.

Quercitron bark extract.

Flavine.

Raw bark (*Quercus tinctoria*).

Rossed bark (*Quercus tinctoria*).

Collections of B. P. Clapp & Co., Pawtucket, R. I.:

Birch, maple, and oak wood, crude naphtha, wood tar, pyroligneous acid, pyrolignite of iron, oak charcoal, birch charcoal, maple charcoal, acetic acid, methyl alcohol, brown acetate of lime, gray acetate of lime, pyrolignite of lead, brown sugar of lead, acetate of alumina, acetate of lime.

Model of still used in dry distillation of wood: German, Smith & Co., Winchester, Va.

Black-oak bark, raw; black-oak bark, rossed; A No. 1 coarse-ground quercitron bark; A No. 1 fine-ground quercitron bark; A No. 1 fine-ground sumac.

Sumac leaves, as gathered and cured for grinding.

Waste from grinding sumac.

Small miscellaneous collection of Canada balsams, oil balsam of fir, oil hemlock, oil white cedar, and oil spruce.

L. Crawford & Co., Chase Lake, N. Y. Rossings, ground bark; spent-bark extract; raw bark (hemlock); rossed bark (hemlock).

APPENDICES.

APPENDIX I.

PRICES OF LUMBER.

The following tables and figures give approximately the average of prices paid for lumber per 1,000 feet board measure, by manufacturers of the industries represented, in the various States where factories are located, from Maine to Minnesota. To these figures are appended statements regarding increase in cost of lumber in ten years:

Sash, doors, and blinds.

Woods.	Lowest.	Highest.	Average.	Location of manufactories.
Ash	$20 00	$25 00	$21 00	New England States and North Carolina.
Birch	8 00	65 00	50 00	New England, Illinois, and Minnesota.
Cherry	20 00	50 00	40 00	New York and Vermont.
Oak (white)	20 00	25 00	21 00	New England and New York.
Black walnut	30 00	180 00	100 00	New England and North Carolina.
White pine	10 00	50 00	30 00	New England, New York, Pennsylvania, Illinois, and Minnesota.
Yellow pine	5 00	15 00	10 00	North Carolina.
Poplar	12 00	40 00	35 00	New England States.
Spruce	14 00	18 00	15 00	New England.

A factory in Vermont quotes beech at $7 per M, and one in New York gives maple at $20. Hemlock is quoted in North Carolina at $12. House finish and moldings average about the same prices.

Building lumber.—But few returns were received relating exclusively to building lumber, principally from the New England States, where prices are quoted as follows: White pine, $8 to $14; yellow pine, $5 to $14 (Southern); spruce, $15 to $18. In Minnesota all kinds of rough house timber costs about $9 to $15 per M.

Shingles.—These figures are quite incomplete, as no returns were received from Michigan and other localities from which a large proportion of the shingle product is derived. The replies are from the Northern New England States, New York, Pennsylvania, and Southern States from Virginia to Alabama:

Woods.	Lowest.	Highest.	Average.
White pine	$5 00	$15 00	$10 00
Spruce	8 00	12 00	9 00
Hemlock	4 00	10 00	8 00
Cypress			10 00
Cedar	12 00	15 00	13 00
Cedar from Dismal Swamp	15 00	18 00	17 00

Mosaic and parquet floors.—Usually high-priced lumber used: White ash, $30 to $60 per M; white birch, $60; cherry, $40 to $80; maple, $65; white oak, $35 to $80; and black walnut, $120.

Moldings.—Insufficient returns to make a reliable average of prices, though the replies received indicate considerably lower prices than those given for parquet flooring woods.

Car-building.—No figures could be obtained from the railroad companies or others engaged in building cars. Street-car lumber ranges in prices as follows: White oak, $40 to $50; white ash, $35 to $45; poplar, $30 to $45; white pine, $20; and yellow pine, $40 per M.

Carriage-building.

Woods.	Wheel parts.			Carriage parts.		
	Lowest.	Highest.	Average.	Lowest.	Highest.	Average.
Hickory	$15 00	$85 00	$49 00	$18 00	$100 00	$46 00
White oak	15 00	45 00	30 00	18 00	60 00	35 00
White ash	15 00	40 00	24 00	28 00	60 00	46 00
Elm	10 00	70 00	35 00	.....	.....	.....

Panels.—Basswood, in thick veneers, $20 per M.; poplar boards, average of $35; birch timber, used for hubs in New York to a very limited extent, $10 per M. In harness parts: Hames, ash, $30; oak, $30 to $60; hickory, $60; elm, $30. Saddle-trees, oak, ash, poplar, beech, gum, &c., $10 to $20.

Ship-building.—Prices in the table include all kinds of timber used in constructing boats, steamboats, and ships. Red oak, not given in the table, averages $25 to $30. Hackmatack, $18 (in Maine). Table of prices for ship-timber is as follows:

Woods.	Lowest.	Highest.	Average.
White oak	$18 00	$40 00	$31 00
White pine	25 00	70 00	41 00
Yellow pine	22 00	26 00	25 00
Spruce	20 00	40 00	26 00
Cedar	20 00	50 00	32 00

Returns made from ship-yards and boat-building establishments in Maine, Massachusetts, Rhode Island, Connecticut, New York, Delaware, and Ohio.

Telegraph-poles.—About $12 per thousand feet for all kinds; the best poles are of cedar.

Tool-handles.—Ax, pick, sledge, hammer, rake, brush, broom, and small tool handles, table of prices per M:

Woods.	Lowest.	Highest.	Average.	States.
White ash	$14	$35	$21	New England, New York, and Ohio.
White birch	15	35	22	New England.
Bass-wood	8	18	14	Connecticut, Ohio, Pennsylvania.
Hickory	10	50	29	New England, Ohio, Pennsylvania.
Maple (hard)	8	35	17	New England and Middle States.
White oak	25	50	35	New England.
Poplar	18	25	21	New England.

Not classified in above: beech, $15, Ohio and Massachusetts; cherry, $10 to $20, New York; walnut, $100.

Agricultural implements.—Including churns, pumps, windmills, &c.:

Woods.	Lowest.	Highest.	Average.	States.
White ash	$20	$30	$24	New England, Ohio, Wisconsin.
Oak, red and white	16	24	22	Vermont, Ohio, Wisconsin, and Michigan.
Poplar	22	32	26	New England, Ohio, Wisconsin.
Maple	15	18	16	Massachusetts, Vermont, Michigan, Ohio.

Bass, $10 to $5; hickory, $22 to 25; white pine, $25; yellow pine, $30.

Carpenters's tools, wood screws, &c.—Beech, $8 to $30; white birch, $8 to $35; hickory, $50 to $100; maple, $8 to $35; black cherry, $40. New England States.

Bobbins, spools, &c.—Beech, $18; birch, $8 to $20; bass, $20.

Surveying instruments.—Woods necessarily purchased in comparatively small quantities. Beech, $40; cherry, $90; maple, $40; white pine, $50.

Wood type.—Maple, $30; cherry, $30 to $60.

Shoe pegs, lasts, &c.—White and silver birch, $15; maple, $15 to $40; persimmon, $25 to $65. New England States, New York, and Ohio.

Baskets.—Ash, $35; bass-wood, $15.

Cooperage.—Replies from New England, Middle and Western States.

Woods.	Lowest.	Highest.	Average.
White ash	$5 00	$40 00	$13 00
Oak	5 00	60 00	15 00
Spruce	2 00	20 00	10 00
Pine, white	5 00	34 00	11 00
Bass-wood	4 00	10 00	7 50
Elm	4 00	10 00	6 50

Maple, average, $25; cedar, $26; cypress, $33; chestnut, $20; beech, $10; birch, $11; sycamore, $10; poplar, $8; hemlock, $6; cotton-wood, $4; red cedar, $10.

Tobacco-boxes, &c.—Poplar for cigar-boxes, $9; sycamore, $22.

Packing-boxes.—White pine, $11; spruce, $10; bass, $12.

Turned goods.—Birch, $5 to $30, average, $15; maple, $12.

Measures, cheese-boxes, barrel-hoops, drum-hoops, &c.—White ash, $10 to $25, average, $16; beech, $11; oak, $16; elm, $11.

Furniture.

Woods.	Lowest.	Highest.	Average.	States.
Black walnut	$15 00	$100 00	$50 00	Vermont, New York, Ohio, Minnesota, Indiana, Wisconsin, Michigan, and Illinois.
White ash	10 00	45 00	24 00	Vermont, Massachusetts, New York, Ohio, Indiana, Illinois.
Beech	7 00	20 00	13 00	New England and New York.
Birch	10 00	22 00	17 00	New England, New York, Indiana, Wisconsin.
Bass-wood	10 00	25 00	16 00	New England, Middle and Western States.
Cherry	25 00	85 00	53 00	New York, Ohio, Indiana, Illinois, Minnesota, Michigan.
Elm	12 00	20 00	18 00	Vermont, New York, Indiana, Illinois.
Maple	9 00	22 00	14 00	New England and Western States.
Oak, white	16 00	40 00	26 00	New York and Western States.
Pine, white	9 00	50 00	21 00	New England and Minnesota.
Poplar	8 00	35 00	23 00	New England and Western States.

Chestnut, $15; spruce, $15; yellow pine, $12; butternut, $30; gum, $50; sycamore, $50.

Wooden ware—Butter-molds, trays, bowls, clothes-pins, and similar articles. Prices average as follows for lumber used, per 1,000 feet: Maple, $7 to $10; birch, $8; cotton-wood, $6 to $8; elm, $4 to $6; sycamore, $5. New York and Ohio chiefly.

Pianos and musical instruments.—About the same average as prices given under the head of furniture.

Toys, building-blocks, &c.—Ash, $25; birch, $25; bass-wood, $14 to $30; cherry, $25 to $35; chestnut, $12 to $20; maple, $16 to $28; oak, $18; poplar, $18; white pine, $40; spruce, $16.

Object forms, geometric solids, &c.—Hard woods average $40 per M; soft woods, $35.

Lead pencils.—Average cost of cedar, 50 cents per cubic foot.

INCREASE IN COST OF LUMBER IN TEN YEARS.

An attempt was made to ascertain the percentage of increase in cost of lumber of all kinds in ten years. The question was ignored by many manufacturers, only about one-half of those replying to the circulars giving answers. While some of the returns indicate that in certain sections, or with particular industries, lumber is cheaper than ten years ago, by far the greater number of answers to the questions show a decided increase in cost. The results are as follows:

Building lumber, &c.—About 50 per cent. of the replies show an average increase of 18 per cent., the range being from 10 to 25 per cent. on all kinds of lumber.

Ship timber and other used in ship-building industries.—Only 30 per cent. of replies: range 5 to 30 per cent.; average increase about 15 per cent.

Carriage-building.—Replies given in two-fifths of the returns, with an average of 20 per cent. increase, the range being from 10 to 30 per cent.

Several large manufactories reporting that there had been no material increase in cost of carriage lumber in ten years, a letter of inquiry was directed to one of the principal manufacturing concerns of the country, asking for opinions as to causes of the same. The following is, in substance, the reply received:

"The principal reasons why the prices of lumber used in carriage-making have not advanced materially in the past ten years, we think are:

"(1) There has been a general shrinking of values in that time, taking gold as the standard; (2) new sources of supply have been made available by the opening of new lines of transportation; (3) the demand in times like the present is largely for cheap goods, and the supply of low-grade timber is abundant and will be so for many years to come. Should business revive we think there would be a quick and decided advance in the best grades, and even as matters now stand we find it difficult to get a supply of good stock of some kinds; yet the condition of trade is such that we cannot safely increase cost."

Tool-handles.—Answers to question in one-third of the replies indicating a general average of 20 to 25 per cent. increase in cost of hickory chiefly, one ax-handle concern in Ohio reporting 50 per cent.

Wooden tools.—About the same as the above.

Agricultural implements.—About 50 per cent. of replies average increase 12 per cent., range 10 to 20 per cent.

Cooperage.—Thirty per cent. of replies show increase in cost, range 5 to 25, average 17 per cent. One concern in Maine reports 40 per cent. increase in cost of oak, and one concern in Ohio reports a decrease of 20 per cent. in pine.

Hoops and other split and shaved woods.—Only two replies, indicating increase of 20 per cent., the question being ignored in all others.

Turned goods.—Increase of 10 per cent. in cost of white birch indicated in Maine. Question generally ignored.

Veneers, excelsior, &c.—Circulars generally report an increase of 10 to 30 per cent.: average 21 per cent.

Packing and other boxes, including tobacco.—No increase indicated.

Furniture.—Fifty per cent. of replies indicate an average increase of 17 per cent. Twelve per cent. of replies indicate a decrease of about 15 per cent.

Pianos.—A very few returns indicate an increase of 20 to 25 per cent. on special woods, walnut being particularly named.

Toys.—A leading toy-manufacturing concern in New England reports an average increase of 10 per cent., this being the only reply to the question.

Other industries are passed over, the replies furnishing insufficient data for even approximate averages of percentages. Supposably little or no increase in cost of lumber used.

APPENDIX II.

GENERAL STATISTICS OF WOOD-WORKING INDUSTRIES.

These figures are presented to illustrate the enormous demand made upon the forest of the United States in a single year by the wood-working industries, or for lumber used in construction, for fuel, &c., to which is appended value of timber lost by forest fires.

TABLE A.—*Showing extent of wood-working industries in the United States, value of product &c. From United States census of* 1880.

Industry.	Establishments.	Capital.	Hands employed.	Wages per year.	Value of products.
Agricultural implements	1,943	$62,109,668	39,580	$15,359,610	$68,640,486
Artificial limbs	33	82,600	72	43,833	137,024
Baskets and willow-ware	304	1,852,917	3,119	657,405	1,992,851
Boxes, packing	602	5,304,212	7,722	2,769,135	12,687,068
Carpentering	9,184	19,541,358	54,138	24,582,077	94,152,139
Carriages and wagons	3,841	37,973,493	45,394	18,988,615	64,951,617
Cooperage	3,898	12,178,726	25,973	8,992,603	33,714,770
Furniture, including chairs	5,227	44,946,128	50,304	23,695,080	77,845,725
Handles of wood	206	1,032,090	1,575	436,664	1,656,698
Kindling-wood	218	1,018,490	1,443	526,861	2,480,953
Lasts and boot-trees	62	477,692	537	308,975	765,296
Picture-frames, &c	645	4,437,666	6,183	2,471,105	9,596,219
Matches	37	2,114,850	2,219	535,911	4,668,446
Organ manufacture	171	3,922,338	4,262	2,142,539	6,136,472
Piano manufacture	174	9,869,577	6,575	4,663,193	12,264,521
Pencils	4	341,597	399	102,115	879,427
Refrigerators	71	727,220	1,053	423,680	1,739,731
Sash, doors, and blinds	1,288	20,457,670	21,898	8,540,930	36,621,325
Sewing-machine cases	18	741,300	1,422	683,338	2,064,837
Shingles, split	45	17,770	193	11,394	47,952
Ship-building	2,188	20,979,874	21,345	12,713,813	36,800,327
Umbrellas and canes	172	2,658,725	3,608	1,158,682	6,917,463
Veneering	5	261,500	141	35,730	292,200
Wheelbarrows	22	266,200	239	72,489	227,392
Wheelwrighting	10,701	10,641,080	16,108	5,074,799	18,892,858
Windmills	69	697,100	596	244,197	1,010,542
Wood pulp	50	1,898,450	1,209	444,778	2,256,946
Wood, carved, &c	710	3,450,710	5,665	2,148,914	6,770,119
Woodenware	287	3,606,794	5,033	1,539,571	5,235,474

TABLE B.—*Table showing product and values of sawed lumber. From census of* 1880.

Lumber	feet	18,091,356,000
Laths	number	1,761,788,000
Shingles	do	5,555,046,000
Staves	do	1,248,226,000
Sets of headings	do	146,523,000
Spool and bobbin stock	feet	34,076,000
Total value		$233,268,729

TABLE C.—*Table showing quantity of lumber used in ship-building in* 1880. *From tenth census.*

	Feet.
Hard pine	39,327,372
White pine	47,506,048
White oak	69,701,360
Total lumber, including other kinds	179,873,966
Knees	97,192

TABLE D.—*Value of timber used as fuel in the census year. From Forestry Report of Prof. C. S. Sargent.*

For domestic purposes (estimated)	$306,950,040
Used by railroads	5,126,714
Used by steamboats	1,812,083
In manufactures and mining	8,073,420
As charcoal (in part)	4,755,420
Total	$326,717,793

TABLE E.—*Miscellaneous uses of woods, with values of product (from same source as above.)*

Railroad-ties	$9,806,247
Railroad-fence posts	180,000
Hoop-poles	1,947,316

To the above should be added the value of tan-bark, there being used in the census year 1,101,526 tons of hemlock bark and 353,245 tons of white-oak bark.

Forest fires (census year).—Areas burned over in acres, 10,274,089: value, $25,462,250.

APPENDIX III.

PROSPECTS OF FUTURE SUPPLY AND NEEDS OF LEGISLATION.

The following views of manufacturers on the general aspects of the forestry question, prospects of future supply of kinds of timber most used by them, and opinions concerning legislation are presented in the form of brief extracts:

Burlington, Vt.—Will be exhausted in twenty-five or thirty years at present rate of consumption. Native woods should be planted, and forests protected.

Mobile, Ala.—As far as the Gulf States are concerned, the pine would last the sawmills for perhaps a hundred years to come; but the timber will, I think, be practically gone in thirty years on account of the destruction wrought in the manufacture of turpentine and rosin. The work should be regulated by law.

Wilmington, N. C.—Twenty years ago we thought the end was in sight; since then we have had a regular supply of twenty or thirty millions annually. The quality is, of course, not so good, as much of the timber is from young trees with more sap than heart. Yet continual avenues are opened by the railroads, and the supply is equal to the demand.

Marshfield, Vt.—I am directly on the line of railroad, and cut nothing but the largest timber, leaving all of the small to grow up, which will be fit to cut in twenty or twenty-five years. It will surely pay to grow timber on or near lines of railroads better than any other crop.

Sandgate, Vt.—The consumption of timber is much greater than its growth.

Chicago, Ill.—Fashion controls the use of wood in our line (church furniture, wood mantels, &c.). The color and grain of any wood can be imitated on any other by skillful staining and graining beyond the ability of any one to detect the difference. We make about all of our cherry work from red birch. It is just as good in every respect. We sell it for cherry, and it is scarcely ever questioned and never rejected, excepting in special cases where the name is considered important.

If there were not another foot of black walnut in the country, the gum would supply its place fully. It seems to us that use of veneers is on the increase. We are constantly using it more and more for all plane surfaces. Facilities of transportation are at present of much more value than the woods. Cases occur where the cost of carrying goods over railroads which monopolize the trade is greater than charges over competing lines by the whole cost of the wood.

Lowell, Mass.—Supply being rapidly exhausted; growing poor in quality and smaller in size every year.

Addison, N. Y.—The supply of pine will last about twenty years.

New York City (manufacture of floorings).—Unless some more effective mode is soon adopted to protect the forests and incentive offered to plant, we shall in a short time have to depend upon other countries for our supplies.

Cincinnati, Ohio.—Ship-timber is becoming very scarce, and in the course of fifteen to twenty years boats must be built of other material.

Acushnet, Mass.—The prospect of future supply of cedar for boat-building is not very bright. Pine timber is the most valuable of any wood that grows about here.

Those that have any large enough for box-boards are cutting it off and selling it to the millers for $6 a cord; but it is getting scarce; there are only small lots to be obtained at any one place. Our supply of yellow oak from Connecticut becomes poorer and poorer every year. Those who send it here tell us that it is getting scarce, it being hard work to get such as will answer. I think there is need of legislation on this question. I suggest offering a bounty for setting trees for timber, or something of the kind, and making laws to encourage those who have suitable land to set trees. There are thousands of acres of land in this State that are covered with bushes and briers which might be converted into valuable timber land with but little expense. Within 4 miles of this place is a 5-acre lot which the owner set to white pine about twenty-eight years ago. The trees are now 15 inches in circumference and large enough to cut for box-boards. The investment has paid him 10 per cent. interest, he thinks.

Newburyport, Mass.—All kinds of timber are growing scarce. I think there should be a law to regulate the cutting of sapling pine for shoe and other box boards.

In consequence of the tendency to use iron for the construction of the hulls of ships and steamers, there is but little demand for oak ship-timber. Hard pine from the South is annually increasing in price, but is mainly used for house-building and bridge-building purposes. The supply is being rapidly reduced by the enormous consumption.

Brewer, Me.—No legislation needed except to be more careful of pine. Fires have killed more lumber in this State than the ax. Pine and spruce grow very fast here. Have known of good sized pine logs being cut in twenty-five years after a fire had burned off the tract.

New York City.—Timber (for car-building) is rapidly diminishing. We find that Western consumers are competing with us in Michigan, Indiana, Kentucky, and Tennessee, and it is not apparent where the supply for the East will next be obtained. Canada lumber should be freely admitted to the United States.

Canton, N. Y.—The State should own the lands on the headwaters of our rivers and should control the cutting of timber.

Chicago, Ill.—There is cedar enough to last for one hundred years, but it will be very expensive in twenty-five years from now. All railroads building west of Mississippi River, north of Missouri, and west of Missouri, south of Iowa, should have been forced to set aside two sections of land for each 10 miles of railroad built, for tree culture.

New Haven, Conn.—A carriage manufacturer writes: "There is no question but what there will be a very small supply in the near future of the best grades of hickory and ash. They are very scarce at the present time, and we would advocate a law which should prohibit cutting either hickory or ash trees under a certain size, and also pay a subsidy to farmers who will plant a certain number of these trees at certain distances apart annually."

Pequa, Ohio.—Think twenty-five years, at the farthest, will exhaust all the hickory in the country.

Mansfield, Ohio.—Regarding hickory, think the supply will be exhausted in twenty years.

A Connecticut wheel manufacturer says: "From the fact that wheel-makers are getting so they scarcely consider the distance a supply of hickory may be removed as an obstacle to its purchase, we consider it certain that ten years will develop either one of these states of affairs: Either some other wood will be used out of which wheels will be made, or some other kind of wheel, made of metal, will be introduced. We consider the latter the most liable to be brought about."

West Chester, Pa.—We find that hickory rim stuff of best quality, which has been found chiefly in a section within 100 miles of tidewater, is becoming more and more difficult to obtain, as it grows only on ground which is valuable for agricultural purposes, and which once cleared off is not allowed to grow up in timber again. The

other kinds of woods used by us are common to a much greater area, and we find no difficulty in procuring all we need at prices as low or lower than those prevailing in the past, as the extension of railroads into new territory and decreased rates of freight enable us to draw from a much larger extent of country. Our observations lead us to believe that the amount of timber going to waste in the United States is greater than the amount made use of, and that while this continues to be the case the cultivation of timber cannot be a financial success in other than exceptional locations. We think it might be well for the Government to establish experimental plantations in order to learn what could be done, with the best manner of doing it, and the probable cost, but doubt the propriety of going further than this at present.

New Lexington, Ohio.—The forests of this country are being exhausted very rapidly, so much so in fact that it is almost an impossibility to obtain a first-class spoke in oak. Second growths are almost out of the question. The timber question of the country is a very important one to us now.

Delphos, Ohio.—Timber for our line (carriage manufacture) will be cleared out in this section within the next ten years.

Fostoria, Ohio.—Twenty-five years ago this Northwestern Ohio was one of the best timbered countries that could be found in the United States; to-day the class of timber that enters into the construction of wagons and carriages is becoming scarce and is in very great demand. Where the supply is to come from fifteen or twenty years hence should be a matter of serious consideration. That there is great need of legislation on that question there is no room to doubt.

A Philadelphia carriage manufacturer writes: "There is no question but that the timber is being cut faster than it grows. The amount consumed by the railroads for ties, in addition to the increased demand from abroad and the regular home consumption (constantly increasing with the increase of population), must force upon the country the necessity of legislation similar to that existing in Sweden, Norway, and Germany."

Another, from New Haven, says: "Hickory, ash, and white wood are being used up much faster than they can grow, and in a very few years will be very scarce and of poor quality. Then it will be regretted that we did not take measures to insure a future supply."

Bristol, Conn.—If I were a young man I would put one-third of my 30 acres in black walnut and wait for it to grow; would reap a rich reward in day's decline.

Greensborough, N. C.—I think that our choice hickory at the present rate of consumption will be pretty well exhausted in twenty-five years from now. The white-oak supply will last much longer from its greater abundance, but it is rapidly being cut, and both timbers, being of comparatively slow growth, will be scarce and valuable in the near future. I cannot see that any legislation will help the matter.

New Haven, Conn. (carriage wood-work).—The forestry question is one of the most important economic questions of this generation, and should receive far more attention from our legislators than it does. All that can be done in regard to old-growth ash and poplar is to protect the supply we now have; it can never be replaced. A supply of second-growth ash and hickory may be obtained by cultivation and the protection of young saplings, and a supply may be obtained in twenty-five years.

What laws are required we cannot say, but we think that something should be done to save the saplings in the States of New Jersey and Connecticut. In forty years these States could furnish an immense amount of the very best of hickory timber, if the destructive waste of the young trees for the purpose of getting hoop-poles could be stopped; but how to stop it is an unsolved problem; yet it must be stopped, or we shall never have any good hickory in these States, for these hoop-pole cutters select the very best for their use and let the poor ones stand. This course must be reversed, but how to do it is a problem we cannot solve. We do not see how law can prevent a man from cutting what timber he chooses on his own land; and as but few men care

anything about future generations, the mass of the people will act as they think best for themselves while living.

Dayton, Ohio.—At the present rate of unnecessary slaughter of timber, the country will be denuded in twenty-five years (hard maple). The larger forests are purchased and cleared for the profit there is in the timber. The farmer who has 100 acres of land, with 15 to 20 of it forest, says: "The taxes are so great, and the yield so slight from his timber land, he is obliged to reduce the area," and so the forest must go. Removal of tax from all timber land would, in a large degree, remove the necessity for cutting out the same on the cleared farms, as well an in the extensive forests.

Norwich, Conn.—Of rock-maple there is a great abundance, but white pine is fast going from the face of the earth, and means should be adopted to grow it anew, as it is the most valuable of all lumber.

Racine, Wis. (*agricultural implements*).—The matter of future lumber supplies is getting to be a serious matter. The better grades of lumber are in good demand; the quality of lumber growing poorer each year; still we manage to get all we require from year to year by paying a fair price, subject to our own inspection.

Athens, Vt.—White ash is becoming very scarce in this section.

Stamford, Vt.—Our timber land is rough, mountainous, rocky, and wet, not fit for cultivation, and after the old timber is cut off it immediately grows up to brush and second-growth, and there is more territory now covered with timber and second growth in this vicinity than there was twenty years ago.

Saint Johnsbury, Vt.—Good supply (spruce and birch) in this section for the next fifty years.

Richmond, Va.—The lumber I use (sycamore) is scattered throughout the States, differing in quality, with advantage in favor of the more northerly and colder climates. Is probably being cut for tobacco-box manufacture and for cheap dwellings, at the rate of 100,000,000 feet annually.

Benson, Vt.—Good timber will be very scarce in twenty-five years.

Delphos, Ohio.—At present consumption of timber I don't think that linn wood can be obtained for manufacturing purposes in Allen, Van Wert, Putnam, and Paulding counties, in this State, in ten years. (Excelsior manufacture.)

Lebanon, Conn.—A prominent handle manufacturer writes: "The question of a future timber supply is an interesting one, both to the manufacturer and to the political economist. Notwithstanding the fact that there has been so little advance in the price of sawed lumber in the past ten years, it is the opinion of many who are well qualified to judge that there must be a material advance in the near future. Several causes have operated to depress the price of lumber at the present time. First might be mentioned a general stagnation of business and almost universal depreciation of values in all manufactured articles. The advent of the portable saw-mill has been an important factor to be considered, not only with respect to the present market value of lumber, but also as affecting the future supply. While this institution was hardly known in this section ten years ago, there is now scarcely a town in this vicinity which has not felt its influence. The effect of setting up such a mill in any section is to make certain kinds and qualities of lumber cheap in that vicinity as long as the supply of standing timber lasts. When this is exhausted, the mill is moved a few miles perhaps, another lot of cheap lumber thrown upon the market, more hillsides denuded, and so the process goes forward as long as there is timber large enough to make railroad ties, and in sufficient quantity to pay for setting up a mill. And this leads me to speak of the vast consumption of timber by the railroads of the country, in ties, bridges, &c. No person who has not taken pains to inform himself upon this point would have any idea how vast this consumption is; and until some better or cheaper material is found as a substitute, our timber supply will be heavily taxed to supply this ever increasing demand.

But it is not merely the legitimate consumption of timber by the railroads which causes apprehension in the minds of those interested in the supply for the future. One

would suppose that these corporations would be actuated by a feeling of self-interest to use all reasonable care in preventing the destruction of standing timber contiguous to their lines of road. This, however, does not seem to be the case. Forest fires in the vicinity of railroads have become so common as to cause a general feeling of insecurity among holders of such property, and a disposition to cut off or sell at the very first opportunity.

In view of the foregoing facts, it would seem desirable that we should have such legislation as will encourage the cultivation of young timber. Whether this can in some degree be accomplished by exempting lands devoted to this purpose from taxation for a term of years, may be an open question; but it would seem that before it can be made a very great inducement for people to invest largely in this kind of property, some method must be devised by which greater immunity may be enjoyed from the reckless destruction to which such property is particularly exposed.

Norwich, Conn.—The northern white birch is a quick-growth wood; probably 20 years would grow wood large enough to cut. Inhabitants of the vicinity where this wood is cut say that it cannot be exhausted this century sure, and do not think it ever will be.

Foxcroft, Me.—This is a matter of vital importance, and should receive special attention from the Government with the view not only of preventing wasteful destruction of our present forest limits, but in every possible way encourage the planting of additional area with such timber as will be of the greatest value when grown. In regard to the special timber I use (white birch), I have no doubt that in the near future all the large growth will be exhausted, so that instead of using trees so large that the wood has to be sawed into squares to reduce it to size, small trees will be made use of, of a size suitable for a single spool; the wood being put in the form of poles when cut, so that the spools will be made from round poles. The supply of this wood, that is, white-birch wood, growing in this way and used as soon as large enough, may be considered inexhaustible, as it grows to such a size in a very short time, and when the necessity occurs it may be cultivated for these special purposes. In view of the foregoing, I do not see as white birch requires any special legislation to protect or to provide for a future supply of timber for spools, &c.

In this connection, I would add that although white birch is the only timber used in this country for spools it is not because other kinds of wood cannot be, but because owing to the peculiar quality of white birch it can be worked with greater economy than any other; so that if the very unlikely thing should happen that we should not have sufficient supply of it, we should not be deprived of the articles now made from it. We should still have them, but at an increased cost, because made from wood more difficult to work.

Woonsocket, R. I.—Think there ought to be legislation relative to cutting our best forest trees. Maple is growing very scarce, and price will in five years be much higher. We find it hard to obtain first quality. The white-birch lumber is also getting so scarce that Canadian parties can ship to many points in our country cheaper than native wood can be purchased. You see by the answer 6*b*, that the price has diminished in ten years. This is caused by competition and by improved logging machinery, and not because the wood is as plentiful. For the same reason the cost of all goods (bobbins, spools, &c.), has decreased 33 per cent. in the same time.

Buckfield, Me.—In this section of Oxford County, I think the yearly growth exceeds the yearly consumption of native woods. Ten acres of waste land are growing up to wood when there is one cleared of wood. Maine is a wood-growing State. There are ten thousand of pine now to one thousand 50 years ago. I have been here 65 years, and know whereof I affirm.

Columbus Grove, Ohio.—The hickory is rapidly disappearing, and constantly increasing in value.

Deep River, Conn.—The timber supply in our vicinity is fast passing away, and can last but a few years longer. We can to-day bring maple lumber from Vermont to our

factory as cheaply as we can buy at the nearest mill. Small portable mills, working on railroad ties and timber, waste more timber than they sell, and are a curse to the country.

Red House, N. Y.—Ash timber cannot last over five years in this part of the country.

New Portland, Me.—Ash lumber is more plenty here now than thirty years ago. I think the white birch is fast diminishing.

Clinton, Conn.—It is a pity that the timber of this section is so nearly gone. There is no place, I believe, on the globe where hickory and oak of as good quality grows as on this coast line, from Maine to South Carolina. Connecticut hickory has always taken in the market preferably to any other.

Hartsburg, Ohio (*ax-handle manufacturer*).—I believe within 20 years the supply will be so nearly exhausted, at least in Ohio, that there will be no factories running in the State.

Hinsdale, Mass. (*ash baskets*).—Wood of many kinds is growing here faster than consumed. There is a scarcity of white ash just now, but there are quantities coming into the market in fifteen or twenty years. The Boston and Albany Railroad took large quantities of wood for many years. So that the wood is, much of it, small (twenty-years' growth), but since the use of coal the consumption of wood is comparatively small and the hills are being covered again.

New London, Ohio.—The writer has been engaged in the timber business for twenty-one years. The larger portion of the time was in buying and manufacturing timber for wagons and carriages, bending, &c. His experience in this section was as follows: From 1863 to 1873 forest hickory and oak were easier to obtain each year and about uniform in price; and from 1874 to 1884 have been continually harder to obtain and gradually increasing in price. But second-growth is much easier to obtain than ten years ago. All of these together with many other observations go to show that in a very few years good hickory, oak, and ash timber in this country will be hard to get for wagon and carriage work, unless some legislation be made to compel or induce land owners to replant a portion of their land. We do not think a law to compel owners of timber land to retain a small portion of same intact would be of any avail, unless about 100 or more acres be left in a body, as the good timber—which is always the tallest trees—will very soon begin to show the effect of the winds and storms, from which it has heretofore been protected by surrounding forests, &c. But timber planted and raised in the open air and sunshine, and cultivated, becomes very hardy and grows very rapidly. For example, a growth of three-eighths to one-half inch on small hickory or oak trees exposed to sunshine is not at all uncommon; consequently a thrifty tree will increase its diameter from three-fourths to one inch a year, and a stick 10 inches in diameter will work very well into spokes, felloes, shafts, &c. But five years more, or 5 inches more, on the outside of the 10-inch stick more than doubles the quantity of marketable timber. Hence in twenty years we might have very good timber for work requiring strong timber. Nearly all the second-growth hickory, ash, and oak which has been cut in this section within the past four years (and which is no very small amount) has grown within the last ten or fifteen years. Therefore we are favorable to such legislation as will bring about such results.

Minneapolis, Minn.—A prominent barrel company replies as follows: It is difficult to give an intelligent opinion on this question. Bass-wood, being of rapid growth and limited consumption, will probably last for generations. Red oak is becoming scarcer each year, and unless some other wood is used more freely for flour-barrel staves, the supply will doubtless be exhausted within the next fifteen years. I refer to the growth in this State, Wisconsin, and Michigan. It would seem that the same reasoning would apply to white oak, which is used largely for car material, the only exception being car sills, 30 feet long and upwards, which are now made somewhat of Norway pine, owing to the great expense of long oak (about double the price of timbers 20 feet long and under). But white oak has declined in price very sharply during the past two years. New lines of road have been opened through the timber belts

of Wisconsin, and small portable saw-mills used largely for getting out hard wood. A locality being stripped of desirable timber, the mill is moved at small expense to a new locality. When timber on short hauls is exhausted, which must be in the course of a few years, white oak must advance rapidly in price, and the supply will probably be then exhausted in the course of twenty years. No legislation is necessary for the protection of this timber, as land owners are fully aware of its value. Elm makes a fairly good barrel and is used to some extent. The supply of this wood is very large.

Maple exists in large quantities, and since the Chicago, Saint Paul, Minneapolis and Omaha Railroad have abandoned the policy of burning wood on their engines the supply of maple in Wisconsin cannot be exhausted for fifty years.

East Jaffrey, N. H.—The supply of old-growth timber in this section is very nearly exhausted, but there is no prospect that the supply of soft-wood saplings will soon give out. There are more acres in this vicinity covered with pine at present than there were twenty years ago. Old farms are being deserted and are rapidly growing up with pine. The growth of hardwood trees, being much more slow, does not keep pace with the demand for them, but with improved processes of manufacture it may be found possible to utilize smaller and poorer stock so that the supply will not be exhausted in many years.

Middletown, N. Y.—An immense waste heretofore; greater saving recently manifested; with present demands, local supply good for thirty years. There will be need to cultivate cherry, which is one of the most valuable woods for furniture, household work, and better grades of manufactured goods. Careful legislation to encourage tree-growing and preserve forests a wise movement.

Menasha, Wis.—Michigan and Wisconsin pine timber will last twenty years.

From a Philadelphia cooperage concern: White cedar grows in the swamps and the land is valueless for anything else. As to future supply, may have trouble to procure supply sufficient for our use. Do not think legislation can help the matter of growth of white cedar, as when swamps are cut the cedar will grow again. There are still large swamps yet in South Jersey not cut, and the Dismal Swamp will serve for twenty years.

Naples, Me.—I think there is nearly as much small pine in this vicinity as there was when I commenced business here some twenty years ago. The first growth is gone long ago, but my idea is that people, at least in this vicinity, are taking very much better care of their small growth than formerly, and many lots of land well covered with small pine growth have been bought by men as investments, and can't be had or cut for any price. The same, I think, is the case to a great extent with the oak, although, that being a wood of slower growth, it will be many years before this will again become the oak section it once was. As far as my business is concerned, I apprehend no trouble in getting all the kinds I use, and sufficient quantities for at least my lifetime, with the exception of oak. As for legislation, I know of nothing that I think would much improve the situation in this section of Maine.

Northumberland, N. H.—The wood we use is a second growth, coming up where the original forests are cut off. It is quick-growing timber, and we find the supply equal to the demand in this section.

North Dansville, N. Y.—This branch of the business must go to the timber country; this portion of New York is virtually without timber. Some few, with foresight, save a piece from the ax, but many large farmers have no wood for fire. During the past twenty years there has been a determination to destroy all timber left, and the prospects for the future in this section will be dependent on railroads, as it is now, for our supply of timber. Michigan and Northern Pennsylvania now furnish us nearly all our timber. Regarding legislation, something should be done to defend our forests, and immediately. The march of the timber hunter is more to be dreaded than that of pestilence, and unless some legislation is done soon protecting what forests are in

hands of the Government, or held by the different States, our children's children will be without timber or at the mercy of heartless monopolies.

Philadelphia, Pa.—The area of land producing white-cedar (or juniper) timber is very limited, being much in demand for the manufacture of cedar-ware, shingles, rail-road-ties, telegraph-arms, and fence-rails; the supply is yearly decreasing. Therefore the prospect for a satisfactory supply in the future is not assuring. This concern understands that "cedar ware" will not bear putting on the market on a basis of prices much beyond those now current, because it finds powerful competition from articles intended for similar purposes, manufactured from white pine, a wood which is procurable in much larger quantity than white cedar and at very much less price. In fact, at the present day, cedar ware cannot maintain itself in the face of such competition in the New England and Western States.

Chagrin Falls, Ohio.—Maple is growing in the immediate vicinity as fast as it is used. There was a large peg-factory here 12 or 15 years ago, and timber was higher then than now.

Fitchburg, Mass.—We think that if there is not some way devised to stop wasting timber, we shall soon be obliged to use foreign woods or stop manufacture. Three trees should be planted to every one cut down.

Dague, Ohio.—The timber we employ in our business (cotton-wood, elm, and sycamore) will be used up in five years, or nearly so, in the State of Ohio. There should be legislation to prevent the wanton destruction of first-growth timber by the saw-mill men. There are at least 40 saw-mills in Paulding County.

South Sterling, Pa.—The timber used here is fast disappearing; nearly as much has been destroyed by forest fires as has been manufactured, most of the large fires having been caused by sparks from passing locomotives. Each year great damage is done to timber from this source; if legislation can effect a remedy it should be enacted.

Middlefield, Conn.—A large manufacturing concern says: Supply gradually diminishing (birch, maple, and pine). Legislation encouraging planting and preservation of timber trees on waste or mountain land and fixing penalties for causing unnecessary fires, and for useless destruction of timber is desirable.

A Chicago furniture manufacturer writes: "We do not think that our forests will be depleted for a great many years to come as there is an immense lot of good lumber uncut in the different sections of our country, and the recent decline in the price of all hard woods seems to warrant this view. The rapid increase in the demand for foreign woods will also tend to preserve our stock of native woods, for some years at least. Nevertheless, our Government should encourage forestry, and especially the culture and growth of walnut, ash, oak, and other hard-wood lumber, beside pine and poplar. Farmers should be shown, through properly written and distributed circulars, what an immense profit the cultivation of timber, and especially black walnut, will yield. Seeds should be distributed, premiums offered, and such other inducements as may seem fit, to encourage and foster the growth of our forests. Schools of forestry might be established and maintained, and the legislatures of the different States should by law exempt such tracts of land as are set apart for new growth of timber from taxation for a term of years."

Robertsville, Conn.—The timber is wasted a great deal faster than it grows. Consequently it is only a question of time when the supply will be exhausted.

Another Chicago furniture-manufacturing company writes: Everybody seems to know that our forests and our resources in this line are nearly ruined already, but every one wishes only to enrich himself without regard to the future. We should have earnest legislation.

A Boston furniture company writes: "We think rigorous legislation is needed to save forests from waste, to encourage the planting of valuable woods, to set aside great national forest parks, and to provide for a forestry commission that will see that public forest lands are not plundered by rings and monopolies. As soon as there is a general re-

vival of business, all the cabinet (native) woods we use will surely advance in price on account of growing scarcity."

Elliottsville, N. Y.—The timber of all kinds is rapidly disappearing, and it is only a question of time when all will have gone, and some varieties have nearly or all gone from this immediate vicinity, viz, ash, cherry, pine, and hemlock.

Grand Rapids, Mich.—The wholesale destruction of lumber should be counteracted, especially of hard-wood kinds, as it will take a long time to repair deficiencies by the growing of trees.

Milwaukee, Wis.—There is but one view or opinion as regards this subject, which is that the way of destruction of timber is carried too far already, and of course either by industrial impulse or enterprise, or by legislation, something must be done, at a very early day too.

Granville, Mass.—The timber is fast diminishing; the railroads are taking our most valuable timber for their ties; trees are cut when 10½ inches in diameter, and in a short time the old growth will be exhausted.

Dolgeville, N. Y.—In our State convict labor should be employed to make roads through the Adirondack region, a State forestry bureau should have stations all through the region to enforce forestry laws, of which the following are most needed: (1) Prevent the cutting of any trees less than 16 inches diameter at the butt; (2) Make stealing of logs or timber a criminal offense with severe punishment.

Franklin, N. H.—The kinds of wood we use (maple, cherry, ash, and birch) are becoming scarcer every year, and unless something is done to prevent waste it will in a very few years be difficult to get a supply.

Windsor Locks, Conn.—Every State should plant new forests and restrict cutting. German plan is a model. Congress ought to stop all cutting, except under restriction, on United States lands at headwaters of great rivers. States likewise. Without some restriction upon the ax, good woods will become extinct east of the Mississippi in 20 years; in New England, in 10 years. There is no more important question before the people than that of the preservation and regrowth of our forests. I believe that the conditions of human life are largely dependent upon the area of forest. The American people in their haste to be smart and rich are killing the fabled goose of golden eggs. Forests would rejuvenate old, sterile countries like Palestine. The absence of forests will rapidly destroy our soil and climatic benefits.

Bearer Falls, N. Y.—The prospect for a future supply of spruce in this country is not very encouraging. The trees are dying off quite rapidly, so that in a few years, with the natural demand, there must of necessity be a scarcity of spruce timber.

Danby, Vt.—The supply of timber in this section will soon be exhausted; in my opinion there will be but little timber standing in 1900.

Ewing, Mass.—There should be practical legislation to replace the wholesale slaughter of timber throughout the country.

TIMBER GROWING.

The following suggestions relative to timber culture are by W. W. Gilette, Bozrahville, Conn:

"Any one who attempts to raise crops from the soil soon learns, if he did not know before, how great an advantage it is that the soil should be adapted to the particular crop he wishes to cultivate. We hear farmers speak of certain fields as being good corn land, or good grass land, &c., and other things being equal he is most successful who studies to know what crops his lands are suited to, and regulates his practice accordingly.

"There is a great deal of land in Connecticut that may be said to be specially adapted to the cultivation of timber. We know this to be the case with regard to much of the land, from the fact that wood of some kind is the natural product of the soil, for if left to itself it rapidly grows up, it may be to chestnut, oak, hickory, or other valuable wood, or it may be to white birch, alder, poison sumac, or something

else equally worthless. There is but little doubt that any land on which the latter kinds grow so spontaneously would, with a little care, produce some of the valuable varieties; for instance, land that seems too poor to bear anything but white birch might be induced instead to bear white pine, especially as this variety flourishes in very poor soil. In like manner the swamps which now abound in alder and sumac might be made to bear white cedar, or even pine, as is attested by the various denuded pine and cedar swamps in different parts of the State.

"One consideration worthy to be taken into account when we contemplate making plantations of timber is that the soil will not be exhausted by its growth as it is by many other crops. It is well known that trees derive a great part of their substance from the atmosphere and from water, the decaying leaves seeming to supply more fertilizing material to the soil than the roots extract from it, for who is not aware that our forest lands when cleared make excellent grass and grain lands until their fertility is exhausted by a process less in harmony with the operations of nature.

"But will it pay to cultivate timber? I answer, it might be questionable policy to put high-priced land to such use; but we have abundance of rocky lands and some not so rocky, which, on account of its distance from market or other causes, is not highly valuable for other purposes. The writer knows of an extensive tract, from which the timber had been removed, which was sold for a trifle over $3 per acre. The price of such lands in this section is generally about $5 or $6 per acre, unless the location is such as to make them desirable for other purposes. Suppose a tract of 100 acres could be bought for $6 per acre: there will be some expense for fencing and taxes, but cutting can be commenced within a few years, cutting only as may be necessary to give the best trees a fair chance to mature. Suppose that this tract is held for thirty-five years. The original purchase money, if it had been placed in a savings bank at present rates, would have only amounted to about $2,400 at the end of that time. There should be, however, upon this tract of 100 acres, if the timber is chestnut, at least 10,000 trees, from 15 to 18 inches in diameter. That this is a moderate estimate I think any one will allow who will take notice how thickly the trees stand in a well-wooded tract. It is to be remembered that the object is to develop the trunk rather than the top of the tree. If the object is to produce telegraph-poles or railroad-ties, the timber need not stand nearly so long; and chestnut timber has the advantage over many other varieties in that it so readily sprouts up from the old stumps and makes a rapid growth immediately after being cut; so that in the owner's lifetime he may possibly harvest two, or perhaps three, crops from the same land.

"And it would seem that there is nothing that can be raised from the soil that is more certain of being a marketable commodity than timber. If it is for railroad-ties and telegraph-poles, we know that the demand was never so great for these articles as at present, and that it is steadily increasing. If it is hard wood, suitable for carriage work or for handles, we know that hickory, oak, &c., raised upon Connecticut soil is sought after and valued much above that from the West or South.

"With regard to the amount of growth to allow before cutting timber, there is this to be observed: there is a proper time to cut a tree as there is a proper time to harvest a crop of corn or grass. If any one in cutting an aged tree will observe the concentric rings or grains, he will usually notice that there has been a period of rapid growth succeeded by a period of very slow growth; and in the case of a very aged tree it often happens that for the last score or more of years growth has come almost to a standstill, the grains being so fine as to show that the tree had but little more than held its own for a long time. Now, for all purposes requiring strength this fine-grained timber on the exterior of the tree, the growth of twenty or thirty years perhaps is about as nearly worthless as anything could well be. And when we consider that the interior of the tree which twenty or thirty years ago was vigorous and strong has been waiting all this time to be put to use until its vigor is exhausted and its strength decayed, it will be seen that it would have been better to cut the tree and obtain the benefit of its good qualities years ago. Much good ink has been

wasted in deploring the destruction of our 'primeval forests,' but there are acres upon acres of trees in Connecticut that have been allowed to stand until their usefulness has been greatly impaired, sometimes destroyed, because we have not given sufficient attention to the proper time to harvest the crop after we had got it raised. Our hope of future timber supply does not lie in the direction of preserving the old, which cannot be preserved beyond certain limits, but in producing the new.

"When applied to carriage-work or handle-making, what is called timber of second growth is greatly to be preferred. The writer has cut trees for tool-handle manufacture whose concentric rings showed an age of 100 to 120 years, but it is rare that a tree of that age will make a handle that is worth putting into a tool. Trees from 12 to 15 inches in diameter are usually of much better quality.

"When it is desired to produce lumber for building purposes an older growth is no doubt desirable; but at present our building lumber is for the most part brought to us from beyond the limits of this State. Whether the time will ever come when it will be produced upon our own soil may be an open question. We do not possess the advantages in producing that class of lumber which we do in some other kinds. We cannot boast of producing a superior article as we can in kinds where great strength is required. But if the depletion of our Western forests is to be continued as it has been carried on for the last decade, the time may soon come when we shall be glad to avail ourselves of any resource for a supply."

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W. L. HOWARD.

CUTTING TIMBER ON THE NATIONAL FORESTS AND PROVIDING FOR A FUTURE SUPPLY.

By

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GOVERNMENT TIMBER SALE POLICY.

The present timber sale policy of the Government on the National Forests is of very recent date. Its development, however, has been gradual and a logical and necessary outcome of the change in the timber conditions of the West. It forms a most interesting chapter in the history of the public land policy of this country. There have been three stages in the Government policy of dealing with the timberland on the public domain, each of which has left distinct marks on the condition of the cut-over land and on the kind of forest that such land will produce:

(1) The period prior to the act of Congress of June 4, 1897, which gave the Secretary of the Interior authority to sell timber from the forest reserves.

(2) The period from the act of June, 1897, to the transfer of these forest reserves to the Forest Service of the Department of Agriculture on February 1, 1905.

(3) The period since the transfer of these Forests to the Forest Service.

THE FIRST PERIOD.

Before the creation of the forest reserves there were laws which dealt with the disposal of timber on the public domain. Several of these laws are still in force on that part of the public domain which is not included in National Forests.

The timber and stone act of June 3, 1878, was the first law which recognized the fact that standing timber has a value in itself apart from the land on which it grows, and that the Government has the right to sell the land for its timber.

The act provided for the sale of tracts not to exceed 160 acres to any purchaser, at $2.50 per acre. Under it cultivation of the land or residence on it was not necessary, but the applicant was required to testify that the land contained no precious minerals and was more valuable for its timber or stone than for any other purpose. The value of a large proportion of the lands which were patented under this act depended upon their timber. When this timber was cut the small trees which remained were usually killed by fire, and much of the land became a barren waste.

Another act of the same date (20 Stat., 88) dealt with mineral lands, and permitted the cutting and removal of timber for building, agricultural, mining, or domestic purposes from such lands within several of the public-land States and Territories.

The Commissioner of the General Land Office issued a circular of instructions to cover the cutting of timber under this act. Briefly, it confined the uses which might be made of the timber to those named in the act, though it provided further that no timber should be used for smelting purposes, that no trees less than 8 inches in diameter should be cut, and that persons who cut timber must dispose of the tops, brush, and other refuse in such a manner as to prevent forest fires. It was impossible, however, to enforce these regulations, chiefly because of the small force of men available. Upon practically all of the cut-over areas the brush was not properly disposed of, and repeated fires followed, killing all the timber which had been left.

Under the act of March 3, 1891, as extended by the act of February 13, 1893, the Commissioner of the General Land Office issued a circular of instructions to regulate the cutting of timber on non-mineral lands. This circular provided that timber might be procured in certain of the public-land States and Territories from unoccupied, unreserved, non-mineral public lands, for firewood, fencing, building, or for other agricultural, mining, manufacturing, or domestic purposes, but not for sale or disposal. The cutting of the timber or lumber was, however, limited to an amount not to exceed a stumpage value of $50 in one year by one person or association without a permit. This law is still in force, but it has been impossible to supervise the cutting of timber under it, and, in consequence, large areas of valuable forest land have been ruined.

A larger part of the timber on the public domain, however, was cut under acts of Congress which were not primarily intended to deal directly with the disposal of timber, but to induce settlers to locate in the West, build homes, and cultivate the land. Thus the Homestead Law of May 20, 1862, granted an area not to exceed 160 acres to each settler who would occupy and cultivate the land for five years. While this law proved very beneficial in building up the prairie section of the Middle West, when applied to the timbered lands of the public domain it became in a great many cases merely an instrument to remove the timber without developing the country or bringing any return to the National Treasury. The commutation clause of this homestead act, under which, after a residence of fourteen months and a cash payment of $1.25 per acre, an absolute title to Government land could be secured, was frequently taken advantage of to obtain patents to lands which were afterwards turned over to corporations and large lumber companies. Thousands of acres obtained in this manner have since been cut over and abandoned.

The lieu land clause of the forest reserve act of June 4, 1897, now repealed, enabled many persons and companies to exchange hundreds of thousands of acres of worthless mountain wastes for valuable timberland, because their original grants had been included in areas set aside as forest reserves. A great deal of the timber so acquired was recklessly cut without any regard for the future of the forest.

In addition, the inadequate supervision of the timbered lands on the sparsely populated public domain offered many opportunities for illegal cutting of timber and for trespassing without detection or punishment. Since it was not possible to secure timber in a regular and open manner various legal disguises were resorted to in order to obtain it, or else it was simply felled without any attempt at legal disguise whatever. This, together with the inability of the force to insure the proper execution of the regulations, resulted in an entire lack of care for the remaining forest or provision for new growth.

As a result of such methods there are now within the 150,000,000 acres of the National Forests in the United States approximately 7,000,000 acres of land which had been burned over and nearly 1,500,000 acres which had been cut over previous to their withdrawal. In the area classed as burned land, which will require many decades to recover from the treatment it received, there are undoubtedly a large number of old cuttings, since lumbering during this period was almost invariably succeeded by fires, which often spread over large adjoining areas and obliterated the traces of lumbering. Fires were often set deliberately to cover trespass cuttings.

The consequences of destructive cuttings are to be seen everywhere through the National Forests, but especially in the lodgepole pine region of the middle Rocky Mountains, where the demand for timber was great. Thus around some of the mining centers near Butte, Mont., large areas were cut over under real or pretended compliance with the provisions of the act of June 3, 1878. Smelters were established in Butte in the early eighties, and as coal was not then available, wood was used for fuel. This, together with the immense quantities used for mining timber, has been a great drain on the forest resources of the region. Wood of all sizes was utilized, and in the tall, dense stands of lodgepole pine on the rounded hills and slopes of this region, clear cutting was the rule. On what is now the Helena National Forest it is estimated that 140,000 acres (218 square miles) were cut over and 3,000,000 cords taken out before the creation of the reserve. Most of this cutting was done before 1897, and in the vicinity of Butte a great deal was done before 1877. No limit except hauling distance was placed on the size of the areas cut clear. Along all the principal streams and creeks clear cuttings extend back from 1 to 3 miles. In some places spurs were run out from the railroads. On Mike Renig Creek, for instance, a spur

track was built up the creek 7 miles and the slopes were stripped clear for from half a mile to 2 miles on each side.

Seed trees were left only by accident, and then on rocky knolls or other inaccessible points. Since no provision whatever was made for the future forest, only 50 per cent of the area is now covered with any reproduction, and less than one-half of this, or 25 per cent of the whole area, will produce a forest as good as the one cut. On the areas which contain only an irregular reproduction and which have been swept by fires it will require many years to produce a forest. Owing to the absence of seed-bearing trees, the few scattered seedlings now present must grow up and bear seed before the areas can be fully restocked. The most striking and desolate appearance is presented where successive fires have swept the ground. In such districts there is no reproduction whatever; nothing but charred stumps and a thick sod of grass or chaparral on the slopes and ridges, which were once covered with stands of trees. Some of these tracts were cut more than twenty years ago, and yet there is no sign of a returning forest. If planting is not resorted to they will remain in the same condition for many years to come.

On the Hell Gate National Forest near Anaconda there is an old clear cutting of 8,000 acres made about twenty years ago. Since then 7,000 acres of this area have been twice swept by fire, and are now without a seedling of any kind.

There are many such tracts, large and small, on the National Forests, especially around mining camps. Occasionally there are areas covered with excellent reproduction, but these are due to accidental combinations of favorable conditions rather than to the methods of cutting. Many areas which were not cut clear and escaped fire contain now a fair reproduction, but usually of inferior species, since the more valuable species were cut out and the poorer ones left to propagate. Unrestricted grazing, especially of sheep, helped to keep down the reproduction on the cut-over areas.

It is not an exaggeration to say that 75 per cent of the old cuttings and burns will for a long time remain unproductive, and a portion of them will never have forest growth again, unless artificially reforested.

THE SECOND PERIOD.

The second period extends from the act of June 4, 1897, to the transfer of the National Forests to the Department of Agriculture.

Although the act providing for the establishment of forest reservations passed Congress on March 3, 1891, no real relief to the situation resulted until 1897, since the bill did not carry with it any appropriation for the care and the protection of the Forests. It is the act of June 4, 1897, that must be considered the turning point in the Gov-

ernment timber-sale policy. This law provided for the control and administration of the forest reserves and authorized the Secretary of the Interior to sell timber from them. The laws under which timber could be secured from the public domain were not applicable to the forest reservations, but any person who needed timber for local needs could obtain it by purchase from the Government at prices which were as nearly as possible the actual value of the timber. No timber could be exported from the State or Territory within which the forest reservations were located, and in this way all the timber sales were limited exclusively to local demands.

The timber was to be sold under rules which the Secretary of the Interior was authorized to prescribe. The regulations which were framed consisted mainly in forbidding clear cutting and compelling the leaving of some trees for future reproduction, in preventing waste by ordering closer utilization of stumps and tops, and in directing the disposal of brush by piling or burning in order to safeguard against forest fires. In many cases, however, even these rules remained practically without power, because there were no technically trained foresters to outline proper regulations for cutting and a very inadequate force of rangers to compel obedience. Yet the condition in which the cuttings were left during this period shows a marked improvement over the previous period.

The policy of the Government with regard to the Forests during this period was not, as it is now, to encourage the fullest use of the land, but almost exclusively to preserve them for the future. This tendency was thwarted to a very considerable extent by determined consumers who cut the timber without permission, in many cases practically regarding the trespass penalties as merely a part of the business transaction of securing the wood. The trespass cuttings were five times as large as the legitimate timber sales. The receipts for sales during the period between June 4, 1897, and June 30, 1904, amounted to only $203,245.87.[a]

THE THIRD PERIOD.

The third period begins with the transfer of the National Forests to the Department of Agriculture.

The general timber-sale policy of the Forest Service at the present time, as determined by acts of Congress and regulations approved by the Secretary of Agriculture, is briefly as follows: The sale of dead timber is everywhere encouraged. Live timber is sold, except where its removal would make a second crop doubtful or would reduce the

[a] While the National Forests were not transferred until February 1, 1905, the report for the entire fiscal year ending June 30, 1905, was made by the Department of Agriculture.

supply so that there would be danger of not meeting local demands, or where injury to streams might follow. With a few exceptions the timber may be exported from the State or Territory in which it is cut. In order to give as much publicity as possible to the sales, the law provides that sales amounting to more than $100 must be advertised for a period of at least thirty days. In each sale the purchaser is required to execute a contract which contains the special regulations under which the cutting must be done. A reasonable time, depending upon the amount of timber included in the sale and the facilities of the purchaser for handling it, is allowed for the completion of the contract, but in no case can this exceed five years. Great care is exercised in awarding sales to prevent a monopoly of the lumber market in any district. In order to prevent the purchase of timber for purely speculative purposes, it is also provided by law that no contract is transferable, and contracts in which a period of more than one year is allowed for the cutting provide that a definite amount of timber must be cut and removed each year. Since the law requires that the full stumpage value of all timber must be obtained, the minimum stumpage rates provided for in the advertisement are, as nearly as can be determined, the full value of the timber. For the past year the cut on some of the Forests on which the timber supply is limited has been restricted, and the annual cut on all the Forests is being definitely limited as fast as the necessary data on which to base this action can be collected. In some Forests sales are limited to the purely local markets, and in a few cases it has been necessary to restrict the annual cut to an amount below the local demand. It is an interesting fact that stumpage rates in Forests which supply a purely local demand are considerably lower than in those Forests from which the lumber is sold in the general market. In this way the Forest Service is able to be of material assistance to the home-builder.

When an informal application for timber is received by an officer in charge of a Forest, he details men as soon as possible to make an examination of the timber tract. In the more important sales, wherever possible, technically trained foresters are assigned to make this examination.

The first consideration is to determine whether or not the sale should be made. The decision depends upon the condition of the timber itself, whether or not reproduction may be expected to follow the cutting, the price for which it may be sold, the necessity for the protection of watersheds, and the reservation of timber for local use. The examiner, after determining the advisability of the sale and the amount of timber, fixes the boundary of the cutting area and formulates the plan under which cutting shall be done. The examination

includes also a careful study of the cost of logging and of market conditions, in order that the true value of the timber may be decided upon for advertisement. Small sales are handled almost entirely by the local force of the Forest. Large sales require the approval of the Forester. In sales amounting to more than $100, at the expiration of the required thirty days' advertising the timber is awarded to the highest bidder, and a contract containing the cutting regulations is prepared. Cutting may begin as soon as the contract is executed.

When the sale has been awarded, the cutting is placed under the direct supervision of one or more Forest officers. The boundaries of the sale area are carefully blazed. All live trees which are to be cut are marked and stamped " U. S." below stump height, and, if the cutting is to be done while there is deep snow on the ground, a second mark is made 3 or 4 feet from the ground. The mark on the stump is used as a check to determine if any trees other than those specified are cut. When Government regulation was first introduced, there was decided opposition among lumbermen and purchasers to the requirement that all trees cut must be fully utilized. During the past year, however, there has been a decided change of opinion (see Pl. XXVI), and now many lumbermen are heartily cooperating with the Forest officers to secure as complete utilization as possible, and are even adopting Forest Service methods on their private holdings.

It is the duty of the officer supervising a sale, in addition to marking the timber for cutting, to see that only this timber is cut and to require that all brush and débris be disposed of according to the terms of the contract. In order to maintain a careful check in the administration of timber sales, inspection is made from time to time by inspectors specially detailed for that purpose, and no sale is considered closed until all the requirements of the contract are fulfilled.

In order to obtain as complete utilization as possible and at the same time improve the silvicultural conditions of the Forest and reduce the danger from fire, purchasers are required in all instances to utilize all merchantable dead timber, and also inferior trees, and, as far as possible, the merchantable trees of inferior species. Trees are now commonly cut and utilized to 6 inches and even 3 inches in the tops, where formerly, in unrestricted lumbering, the limit for tops was often 12 inches or even more. Stumps are now cut to a height of from 6 to 18 inches, where formerly they were cut to 3 or 4 feet or even more. (See Pl. XXVII.) Purchasers of timber from the National Forests in the Northwest are now utilizing fully the western hemlock, which was formerly considered almost worthless. In the Rocky Mountains, Alpine fir, black fir, and blue spruce are being taken to good advantage.

PROVISIONS FOR REPRODUCTION ON CUT-OVER AREAS.

The chief aim underlying the present administration of the National Forests is the maintenance of a permanent supply of timber and the conservation of water resources. It is intended to accomplish this, not by withholding the mature timber from cutting, but by actively engaging in use of the Forest. "Through use to a greater use," is the motto of the Forest Service. The continuity of the timber supply depends largely on the way timber is cut now. The regulation of cutting is therefore the most critical and responsible task of the whole activity of the Forest Service and is at the foundation of all present forest management on the National Forests.

There are at the present time in the United States about 160 National Forests, with an area of approximately 150,000,000 acres. From the 64,000,000 acres which it is estimated are covered with about 330,000,000,000 board feet of merchantable timber, more than 1,000,000,000 board feet of timber was sold during the fiscal years 1906 and 1907 for approximately $2,500,000. Not all of this amount was actually cut, however, since contracts in many of the larger sales allow several years for the cutting and removal of the timber.

Sales are well distributed throughout the West and vary in size from a few cords of wood to many million feet, board measure. Even the large sales are not confined to any particular district. Several have been made in the lodgepole pine Forests of the Rocky Mountains. Large quantities of yellow pine are now being cut in the Forests of the Southwest, and extensive operations are being started in the Forests of California and the Northwest. Large sales, however, are the exception rather than the rule, since most purchasers from the National Forests obtain timber in small quantities either for their own use or for the community in which it is cut.

The National Forests have been under the administration of the Forest Service for less than three years, and some have not yet been organized for a full year. It is impossible, therefore, to predict the future of the cutting, except by inference, from the condition in which they stand at present.

The National Forests may be classified into four groups, according to the silvicultural problems prevailing on them. This classification does not hold for the Minnesota National Forest, where the reproduction of white and Norway pines in competition with the aggressive jack pine is the chief problem, nor for the Black Hills Forest, where beetle ravages place it in a class of its own. These groups do not, as a rule, end abruptly, but merge gradually into one another. The four classes are as follows:

(1) The Rocky Mountain group, comprising the Forests of Montana, Idaho, Wyoming, northern and central Utah, and northern

FIG. 1.—THE OLD WAY.
[That part of the felled tree shown in the picture was left in the woods to rot.]

FIG. 2.—THE NEW WAY.
[The whole tree utilized; brush piled for burning.]

METHODS OF LUMBERING.

Yearbook U S Dept. of Agriculture, 1907.

FIG. 1.—BEFORE CUTTING.

FIG. 2.—AFTER CUTTING.

LUMBERING UNDER THE SUPERVISION OF THE FOREST SERVICE.

and central Colorado. Here the main silvicultural problem is the reproduction of lodgepole pine. This group can be subdivided into two parts: (*a*) Northern, where, besides the lodgepole pine, the yellow pine, and, toward the west, the Douglas fir claim attention; (*b*) Southern, where, besides the lodgepole pine, the Engelmann spruce is an important species, with distinct problems of its own.

(2) The Cascade Mountain group, embracing the Forests of Oregon and Washington. Here the problem is the increased production of Douglas fir to supplant hemlock.

(3) The Sierra group, including the forests of northern and central California. Here the problem is how to obtain, in a mixed forest of yellow and sugar pine, white fir, and incense cedar, the reproduction of the pines to the exclusion of fir and cedar.

(4) The Southern group. This is not confined to one physiographic region, but extends over the coast mountains of southern California, the Colorado plateau, and the southern Rocky Mountains, including the Forests of southern California, Arizona, southern Utah, southern Colorado, and New Mexico. Here the main silvicultural problem is the reproduction of yellow pine, the character, rapidity of growth, and general behavior of which are practically the same throughout this group, but very different from those of the yellow pine in California and Idaho.

For each of these groups there has been worked out and adopted a definite plan of silvicultural treatment, which is usually embodied in a set of marking rules for each individual timber sale within the given group and forest type.

Thus in lodgepole pine forests, tracts in some sales are cut clean, except for groups of seed trees at regular intervals. In other sales only selected, mature, overmature, or defective trees are taken. In still others strips of seed trees are left. (Pl. XXVIII.) In most cases, lodgepole pine is severely cut, because such cuttings, when followed by burning over the ground after the branches have been lopped, result in dense reproduction. In a lodgepole pine forest there are always on the ground many unopened cones of several seed years. A surface fire opens the cones and releases the seed, which often results in enough young growth to make the leaving of seed trees almost unnecessary.

In Engelmann spruce forests, light cuttings which do not disturb the forest conditions, with careful protection from ground fire, produce the best results. The Engelmann spruce seeks moist situations; it is found at high elevations near the timber line, mostly on springy ground, and on northern slopes. If it extends to lower elevations it is only along water courses. Heavy cuttings, by letting in too much sunlight, would dry up the ground, and so prove fatal to Engelmann spruce. Light cuttings do not interfere with the reproduction of the

tree, since it is capable of coming up under shade, and there is always a good proportion of young growth in an Engelmann spruce stand.

In the Cascade group, heavy cutting, together with the retention of a few seed trees, and burning over the cutting area is practically the only way of getting a good reproduction of Douglas fir where it occurs with hemlock. Observations have proved that where Douglas fir has been lightly cut over and the ground cover unburned, it is followed by the less valuable hemlock. Hemlock is a tolerant species; it needs protection from the sun; and it requires for its generation a fairly deep leafy mulch; in other words, precisely the conditions found in a lightly cut-over Douglas fir stand. Douglas fir requires exactly the opposite conditions. It is intolerant, and comes up only in a good mineral soil. Many fine stands of second growth Douglas fir owe their reproduction to the ground fire after heavy cutting.

In the Sierra group of the National Forests, conservative cutting is the rule. Only old, mature, and decaying trees are marked for removal, while all sound and thrifty trees, which, though merchantable and mature now, will live for the next fifty years, are left. These trees are expected to produce within the next fifty years a second cut of an amount sufficient to justify logging. In the meantime they will act as seed trees and stock the ground with young trees for a third crop. Efforts are being made in these National Forests to prevent the increase of white fir and incense cedar, which are inferior trees and of little commercial value, and to favor the more valuable pines. Almost invariably the inferior species in mixed stands are cut to a much smaller diameter limit, and where they are a decided detriment to the forest, even the destruction of seedlings and young trees of these species is encouraged during the lumbering operations.

In the Southwest, the most common method is to cut to diameter limit and leave enough seed trees to insure reproduction. As a rule only thrifty, fast-growing trees are left; where there are not enough of them to reseed the ground, large mature trees are left for this purpose. The question of leaving a sufficient number of good seed trees is carefully considered in all marking, even when leaving such trees means a decided reduction in the receipts from timber sales.

MARKING TIMBER.

The importance of careful marking is now more completely understood than ever before, and is emphasized in every possible way. Whenever possible, the Forest officers best qualified, preferably technically trained men, are assigned to this work. The plan for the cutting is determined upon only after a careful study upon the ground, and reference to all available information both in the local office and in the office at Washington. This plan, however, may be changed

STRIP METHOD OF CUTTING ON NATIONAL FORESTS.

[Brush piled and ready to be burned as soon as logs are removed.]

from time to time, even during the course of the sale, if the conditions seem to demand, provided such a change is not inconsistent with the terms of the contract. Different methods of cutting are being tried with various species on a scale large enough to make the results of great practical value.

DISPOSAL OF BRUSH.

Next to marking timber and leaving seed trees, the disposal of brush resulting from lumbering has the most decided effect upon the future of the cuttings. The greatest danger from leaving the slash scattered about, or piled just as the choppers have left it, is fire. Probably 90 per cent of all cuttings on which the brush was not disposed of have been burned over, which will retard a second crop for fifty or one hundred years.

The manner of disposal, whether by scattering, ground burning, piling and burning, or piling and not burning, is dependent upon the conditions in each case. Thus, on thin soils and steep slopes at high altitudes, where the danger from fire is small, it has been found most advantageous to lop and scatter the brush to form a mulch and protect the soil from erosion. In the Northwest, in sales in which all trees except seed trees are taken, and it is desired to obtain Douglas fir reproduction, the cutting is completely burned over. In the majority of cases the brush is piled and, when there is any danger from fire, it is burned. The purchaser is usually required to pile the brush, but in most cases the burning is done by Forest officers.

As a result of the disposal of brush, the unsightly appearance so characteristic of the old-time cuttings on the public domain, where no effort was made to dispose of tops and lops, no longer exists.

PLANTING.

The high cost of forest planting and the unfavorable conditions for it throughout most of the western mountains make it necessary to depend, as a general rule, upon natural reproduction to restock the ground. There are, however, many million acres of denuded land within the National Forests which must be artificially planted in order to make them bear a forest growth. Such planting has already been inaugurated, but the area which needs to be planted is enormous, and the work now is confined chiefly to the lands which need a forest cover most, that is, to watersheds upon which cities and towns are dependent for their supply of water. The first planting of this kind was done in 1902, in the vicinity of Pasadena, Cal. Since then similar work has been done on city watersheds in Colorado, Utah, Idaho, and New Mexico. Some planting has been done also in the Black Hills National Forest, where there are large areas of cut-over and burned-over land which are entirely without seed trees and where the need for mining timber is urgent.

The planting in the sand-hill region of Nebraska must also be mentioned, although it is not connected with the reclamation of cut-over and denuded land, since the sand hills are naturally devoid of forest growth. At present about 2,000,000 seedlings have been planted on the National Forests on more than 2,000 acres. This is only a small beginning in comparison with the amount of planting that must be done. Everything connected with the work is new; there are no precedents to follow, and each phase must be worked out step by step.

The planting operations of the Forest Service are now concentrated at six large planting stations: One in southern California, one on the Dismal River National Forest in Nebraska, one on the Pikes Peak Forest in Colorado, one near Fort Bayard, N. Mex., one on the Salt Lake Forest in Utah, one at the Pocatello National Forest in Idaho, and one on the Pecos River Forest in New Mexico. At each of these stations nurseries are maintained where stock is raised for planting on the local Forest and for shipment elsewhere. The total area of these nurseries at present is nearly 14 acres, and their annual productive capacity is between 8,000,000 and 10,000,000 seedlings. Each nursery is practically an experimental forest planting station. A large variety of species are tested and various methods are tried.

In the future, when stumpage prices become higher and forest products are more completely utilized, clear cutting with subsequent planting, as is practiced in the more densely populated States of Europe, may perhaps become practicable on many of the National Forests. Planting then will be the quickest and surest method for restocking cut-over areas. Until then, however, natural reproduction will remain the cheapest and, under the circumstances, the only practicable way of securing the continuity of our forests.

CONCLUSION.

Such, in brief, are the measures by which the Forest Service hopes to provide for a future forest on the land that is now being cut over. Time alone can show whether these measures are effective or not. No doubt there will be mistakes and failures. On some cuttings reproduction will not be as dense as hoped for; on others it will not be of the kind that was expected. But, if the experience gained by long years of systematic forest management abroad and the lessons taught by the old cuttings in this country count for anything, the land cut under present provisions will not become barren waste, as most of the old cuttings have, but will be continuously producing timber of commercial value.

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THE DETERMINATION OF TIMBER VALUES.

BY

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Forest Assistant, Bureau of Forestry.

[Reprint from Yearbook of Department of Agriculture for 1904.]

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THE DETERMINATION OF TIMBER VALUES.

By EDWARD A. BRANIFF,
Forest Assistant, Bureau of Forestry.

INTRODUCTION.

In the past it has been customary to base estimates of probable profits from the management of lands for the future production of timber in the United States upon the increase of the timber in quantity. Everyone familiar with the lumber business knows, however, that the lumber which comes out of large trees is worth more per thousand feet than that which comes from small trees, because the large trees turn out a higher proportion of the choice grades. It is apparent that estimates of profits through careful forest management should take into account this factor of quality increase; but, in the absence of an accurate determination of what this quality increase is, it has hitherto been impossible to do more than state in general terms the fact that such an increase would take place and that its effect would be to make the profit from deferred operations greater than that actually shown by the figures indicating the future yield to be expected.

DESCRIPTION OF THE EXPERIMENTS.

During the winter of 1903–4, and the following spring and summer, experiments in sawmills in different parts of the country were conducted by the Bureau of Forestry. This article will be confined to a statement of how the experiments were performed, to extracts from some of the tables and the printing in full of others, and to a brief discussion of their application.

The experiments completed so far have to do with longleaf pine in Alabama and in Louisiana, and with yellow birch, sugar maple, and beech in the Adirondacks of New York. The results here reported were obtained mainly from Adirondack hardwoods. Further experiments are now progressing in the Appalachians of West Virginia with yellow poplar, white oak, chestnut, ash, and other hardwoods typical of that region.

The main question which the experiments were to answer was: Exactly how much more valuable is a particular kind of tree of a certain size than another tree of the same kind and of smaller size? Clearly, the matter could be got at only by following the logs from trees of all diameters through the sawmill and finding out what each sawed out in amounts and grades of timber. And since the experiment was concerned not with individual logs, but with whole trees, all

the logs from each tree had to be traced in such a way that the aggregate product might be known. So men were placed in the woods who followed the saw crews, scaled each log, and marked it on the ends. Each tree was given a number and each log in that tree an additional figure, as 1, 2, etc., to indicate the first log, second log, etc. For example, 576^2 indicated the second log from tree 576. The logs were scaled according to the log rule locally used, as a check for their identification and in order to compare their contents according to the log rule with what they actually sawed out in the mill.

In the mill a man was stationed next to the slab carrier, and as each piece of siding from a marked log dropped on the live rollers this man chalked on it while it went by the number of the log from which it came. When a marked siding had passed through the edger and trimmer and had come out at the end of the mill a piece of manufactured lumber, it was graded by a competent inspector, and its log number, dimensions, and grade were tallied. By these means the contents of each log, both in grades and in quantities of lumber, were absolutely determined.

This, in brief, was the method used for all species except longleaf pine. In the case of longleaf pine the number of men available for the work was not sufficient to trace each piece of siding through the mill to see what it actually made in lumber. Instead, it was graded as it dropped from the saw and its contents were estimated.

In working up the results, the logs that had passed through the mill were first combined to form complete trees. If a log were missing, the results for all the rest of the logs from that tree had to be thrown out. An exception was made in the case of Adirondack hardwoods, when the missing log was an 8-foot top cut of just sufficient diameter to make a railroad tie and one or two boards of the inferior grades. In such cases the missing log was graded like a top log of similar dimensions and species from another tree. In no instance was this substitution used for any but small, knotty, 8-foot top logs, and then only when it could safely be done.

The trees were next divided into diameter classes varying by 1 inch, and all the lumber from each class was tallied by separate grades. The total number of feet of each grade was then divided by the number of trees tallied for that class, and the result was the average amount of lumber of that grade. Finally, the figures for each grade were rounded off by curves to reduce irregularities.

RESULTS OF EXPERIMENTS.

The results of these measurements were two tables for each species, one showing the number of feet of each grade of lumber sawed from a tree of given diameter, the second showing the money value of the lumber yielded by a single tree of each size, and the average value per

thousand feet of the lumber. The tables showing money values were made by applying to the tables of grades the average selling price of the lumber at the mill.

YELLOW BIRCH.

The following table gives the grades for yellow birch:

Graded volume of yellow birch.

Diameter breast-high.	Firsts and seconds red.	Firsts and seconds.	No. 1 common.	Shipping culls (No. 2 common).	Mill culls (No. 3 common).	Sound 7″ by 9″ by 8′ ties. (a)	Total.	Number of trees tallied.
Inches.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	
13	.....	3	5	6	20	25	59	7
14	.....	7	7	7	37	37	95	16
15	.....	11	10	8	41	55	125	23
16	.....	16	12	8	38	72	146	32
17	.....	22	14	8	35	84	163	32
18	2	28	17	9	36	94	186	57
19	4	36	20	10	45	102	217	50
20	8	44	24	11	55	108	250	39
21	23	54	28	13	65	114	297	40
22	26	66	31	15	74	119	331	46
23	36	78	33	16	82	118	363	25
24	48	86	36	18	88	112	388	37
25	62	92	38	19	93	104	408	30
26	81	97	42	20	98	96	434	24
27	101	108	47	22	106	91	470	28
28	116	110	53	22	118	86	505	16
29	128	120	59	23	134	81	545	4
30	139	132	64	24	155	74	588	12
31	150	144	68	25	180	52	619	4

a To obtain number of ties divide board feet in this column by 42.

This table shows the yield of choice grades of birch advancing rapidly with the growth of the tree. The choice grades are firsts and seconds red and firsts and seconds. The amount of red birch in a tree under 18 inches in diameter is too small to consider. An 18-inch tree contained 2 board feet of this high-priced lumber, a 19-inch tree only 4 feet of it, a 20-inch tree 8 feet, but in a 21-inch tree the amount rose to 23 board feet, showing a gain of almost 200 per cent over the product of the previous diameter. The explanation for the exceptional increase is that the rules of the National Hardwood Lumber Association, under which the lumber was inspected, require red birch 4 or 5 inches wide to show one face all red; over 5 inches, one face must be not less than 75 per cent red. Red birch is heartwood, and it happens that the heartwood is not wide enough to pass the severe inspection in considerable quantities in trees under 21 inches in diameter. The increase of red birch goes on steadily from the 21-inch to the highest diameters. The next best grade, firsts and seconds, not graded by color, is contained in practically all sizes of merchantable trees. The increase of

this grade goes on steadily, but is greatest between 18-inch and 23-inch trees, because the inspection rules, which favor wide boards, show their greatest effect here. Narrow boards from small trees grade lower than wide boards from large trees.

When we compare the choice grades (firsts and seconds red, and firsts and seconds) with the common ones (No. 1 common, shipping culls, and mill culls) we find that the choice grades increase, on the whole, much more rapidly with the growth of the tree than do the latter. In the case of firsts and seconds red there was a rise between a 13-inch and a 31-inch tree from 0 to 150 feet; and in the case of firsts and seconds from 3 to 144 feet. Contrast this with No. 1 common, which rises from 5 to 68 feet; with shipping culls, which rise from 6 to 25 feet; and with mill culls, which rise from 20 to 180 feet, and the tendency of the better grades to outstrip the poor ones becomes apparent. The fact must not be overlooked, however, that a considerable amount of what would have made inferior grades went, in this instance, into railroad ties.

The following price list for hardwoods was made up after inquiry among hardwood jobbing houses in New York and Boston:

Prices of different grades of lumber from birch, maple, and beech trees.

Grade.	Price per thousand board feet.		
	Birch.	Maple.	Beech.
Firsts and seconds red	$33		
Firsts and seconds	23	$20	$14
No. 1 common	14	14	10
No. 2 common (shipping culls)	8	8	7
No. 3 common (mill culls)	6	6	6

In most instances the lowest price quoted was used. The value of the railroad ties was assumed to be 40 cents for a 7 by 9 inch tie 8 feet long, equivalent to $9.52 per thousand feet—a reasonably low price.

The figures given afford a basis for calculating the value of yellow birch trees. For example, take a birch 21 inches in diameter. Turning to the table of grades we find that such a tree contains 23 feet of firsts and seconds red, worth, according to the price list, $33 per thousand; 54 feet of firsts and seconds at $23; 28 feet of No. 1 common at $14; 13 feet of shipping culls at $8; 65 feet of mill culls at $6; 114 feet of railroad ties at 40 cents per tie of 42 feet—in all, 297 feet, worth $3.97, or $13.37 per thousand feet, at the mill.

It must not be supposed, however, that as a matter of fact the exact value of a tree of a given diameter can be calculated with absolute accuracy on the basis of the figures herewith presented. The purpose of the present article is to give an indication of the rate at which the timber value of a tree increases with its diameter growth, in

consequence of the higher quality of lumber which it will yield. The number of yellow birch trees tallied for the various diameters in the above table of grades ranged from 4 to 57, and, as has already been stated, the figures of yield of the several grades given in the table do not represent the actual product sawed out, but were obtained by constructing curves to round off the inequalities shown by the actual individual averages in order to secure a nearer approximation to the general average. That the inequalities thus rounded off were in some cases considerable goes to prove that it would be unsafe to rely too closely on calculations from this table of the exact yield to be expected.

Further, the judgment of both the sawyer and the grader enters into the determination of the amount of lumber of each grade which a particular log will yield. Had the logs tallied been sawed at another mill, or even at the same mill at another time, the figures would have varied slightly. Under no circumstances is it possible to construct a table which will enable one to tell infallibly how much lumber of different grades a single tree will saw out. It is, however, possible for an owner to calculate pretty closely from the above table what he may expect to saw from a considerable body of timber of known size. From this again it is possible to construct a table of values like the following:

Value of yellow birch.

Diameter breast-high.	Graded volume.	Value per tree.	Value per 1,000 bd. ft.	Diameter breast-high.	Graded volume.	Value per tree.	Value per 1,000 bd. ft.
Inches.	*Bd. ft.*			*Inches.*	*Bd. ft.*		
13	59	$0.55	$9.32	23	363	$5.19	$14.30
14	95	.89	9.37	24	388	5.80	14.95
15	125	1.22	9.76	25	408	6.39	15.66
16	146	1.52	10.41	26	434	7.15	16.48
17	163	1.78	10.92	27	470	8.03	17.09
18	186	2.13	11.45	28	505	8.80	17.43
19	217	2.56	11.80	29	545	9.57	17.56
20	250	3.06	12.24	30	588	10.34	17.59
21	297	3.98	13.40	31	619	10.99	17.75
22	331	4.51	13.63				

SUGAR MAPLE AND BEECH COMPARED WITH YELLOW BIRCH.

Similar tables were constructed for sugar maple and for beech in the Adirondacks, and for longleaf pine in Alabama and in Louisiana. The following extract from the hardwood tables gives a comparison of the value of the lumber sawed from birch, maple, and beech of different diameters.

Value per thousand feet board measure of lumber from Adirondack hardwoods.

Diameter breast-high.	Yellow birch.	Sugar maple.	Beech.	Diameter breast-high.	Yellow birch.	Sugar maple.	Beech.
Inches.				*Inches.*			
13	$9.32	$9.75	$8.29	23	$14.30	$12.77	$9.71
14	9.37	9.83	8.70	24	14.95	12.88	9.68
15	9.76	9.93	8.94	25	15.66	12.93	.....
16	10.41	10.37	8.98	26	16.48	13.07	.....
17	10.92	10.71	9.10	27	17.09	13.26	.....
18	11.45	11.11	9.24	28	17.43	13.58	.....
19	11.80	11.47	9.38	29	17.56	.....	.....
20	12.24	11.84	9.45	30	17.59	.....	.....
21	13.40	12.30	9.52	31	17.75	.....	.....
22	13.63	12.57	9.61				

According to this table lumber from a 24-inch birch tree is worth $5.63 a thousand feet more than from a 13-inch tree; from a sugar maple, $3.13; and from a beech, $1.39.[a] The difference is more marked in the case of birch largely because of the presence in the high diameters of the high-priced grade, firsts and seconds red. The table for birch gives values up to 31 inches. A lumberman in cutting all sizes of birch would get, according to these figures, $8.43 per thousand feet more from his 31-inch trees than from his 13-inch trees.

The increase in value of the lumber with the growth of the tree was found to be much more rapid in the case of Adirondack birch and maple than in that of longleaf pine. The difference in value per thousand feet of the lumber from 14-inch and from 24-inch pine was $1.72, while the difference between the same diameters of birch was $5.58, and of maple $3.05. This is accounted for partly by the fact that the inspection of narrow boards is more severe with hardwoods than with pine, partly because the difference in value between poor and choice lumber is more marked in the case of birch and maple than in that of pine. The comparison is, however, not strictly a fair one, for the reason that in the experiments with longleaf pine very defective trees were rejected, while in the hardwood experiment the run of the forest at McKeever, N. Y., was taken.

PRACTICAL VALUE OF THE RESULTS.

The practical uses to which such tables might be put are apparent. With due allowance for slight changes in the character of his timber, any Adirondack lumberman could use them as a basis for figuring out, with his own price list, the values of his hardwoods. If he knows what the expenses of stumpage, logging, and manufacture amount to, he would be able to determine within close limits what trees he could cut at a profit and what trees he had better leave in the woods. In

[a] Beech over 23 inches shows a falling off in quality due to decay.

brief, he would have at hand an excellent guide to assist him in lumbering and in fixing a value on his timberlands.

Wherever surveys have been made which show the number of trees of various diameters of each species on the average acre, the tables of value could be used with peculiar effectiveness. Such surveys have been made on a number of tracts in the Adirondacks by the Bureau of Forestry. In a working plan for a tract at McKeever, N. Y., the lands were divided into six types, and the number of trees of each diameter for each species on the average acre was determined for each type. In a working plan made for a tract at St. Regis, N. Y., the number of trees of each diameter of each species on the average acre was determined for all types combined. On virgin hardwood land on the McKeever tract there were, on the average acre, of 17-inch trees, 0.80 yellow birch, 0.70 sugar maple, and 1.34 beech; of 18-inch trees there were 0.66 birch, 0.68 maple, and 0.96 beech, and so on. If all expenses of stumpage, logging, and manufacture should be as low as $10.50 on 17-inch trees there would be a profit of 42 cents per thousand feet on birch and 21 cents per thousand feet on maple. And the larger the tree cut the higher the profit. Should all birch and maple be cut down to and including 17-inch trees, there would be, with expenses at $10.50, a profit of $11.32 per acre, of which $9.82 would be from birch and $1.50 from maple. The average profit per thousand feet on all trees cut would be $4.15 from birch and $1.49 from maple.

But the profits from small trees are so slight as to make it hardly worth while removing them; certainly inadvisable if a future timber crop is to be considered. Calculating again, we find that the profits from birch and maple, if cut down to and including 18 inches, would be $11.26; cutting to 19 inches, they would be $11.06; cutting to 20 inches, they would be $10.72 per acre, etc. It will be noted that, while the smaller the cutting limit the higher the profit per acre (unless trees are taken so small as to cause an actual loss), the lower is the profit per thousand feet on the timber removed; on the other hand, the higher the cutting limit the lower is the profit per acre, but the higher the profit per thousand feet on the timber removed. Cutting birch and maple trees 17 inches and over, the profit per thousand would be $5.64; trees 18 inches and over, $6.04; trees 19 inches and over, $6.46; 20 inches and over, $6.91. "Profit per acre" and "profit per thousand feet" work in opposite directions.

Expenses vary according to distance of the timber from the means of transportation, conditions in the woods, topography, cost and quality of labor, etc. An expense of $10.50 for logging and manufacture, including stumpage, is generally considered low for hardwood lumbering in the Adirondacks, and when the expense is more than $12.75 operations are, in many cases, scarcely practicable. The profits per acre and per thousand feet in lumbering birch and maple when

expenses are $10.50, $10.75, $11, $11.25, $11.50, $11.75, $12, $12.25, $12.50, and $12.75 per thousand feet were calculated for the tracts mentioned above, and the results do not encourage indiscriminate cutting of hardwoods in the Adirondacks; on the contrary, they furnish the strongest possible argument against careless lumbering. Hardwood lumbering in the Adirondacks is so expensive that as a rule it does not pay to cut any but the larger trees for lumber. It is highly to the advantage of the lumberman to know just at what diameter limit his profits are turned into losses, and it is equally to the advantage of the future productive capacity of the forest that he should know this. These figures prove that the lumberman who would make the highest profits out of the Adirondack hardwoods must cut within certain diameter limits and leave, in most cases, a considerable stand of timber uncut. The argument is based not at all on what is best for the forest, but entirely on present expediency for the lumberman. It happens, however, that what is best for the lumberman turns out, in this case, to be excellent for the forest. Hardwood lumbering in the Adirondacks is not yet on a large scale, but with the growing scarcity of timber and the advancing prices of lumber there is little doubt that it soon will be. Every effort should be made to induce Adirondack lumbermen to regulate their cutting and to show them that in taking small trees they are working directly against their own interests.

Walter Mulford Issued October 21, 1908.

U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE.
GIFFORD PINCHOT, Forester.

EXTENT AND IMPORTANCE OF THE CHESTNUT BARK DISEASE.

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EXTENT AND IMPORTANCE OF THE CHESTNUT BARK DISEASE.

INTRODUCTION.

Three years ago a destructive fungous disease of the chestnut first attracted attention and almost immediately assumed the character of an epidemic. It seems to be one of the most serious diseases which has ever attacked an American forest tree, and has done great damage locally in and around New York City, and is now spreading rapidly in all directions to forest tracts in Connecticut, New York, New Jersey, and even into Pennsylvania.

The disease was first studied by Dr. W. A. Murrill, of New York, and during the past eighteen months it has been under investigation by Dr. Haven Metcalf, of the Bureau of Plant Industry. The technical details given in this circular have been derived chiefly from the publications of the former and information supplied by the latter.

MANNER OF INFECTION.

The disease is caused by a fungus known as *Diaporthe parasitica* and *Valsonectria parasitica*, the spores of which enter the tree through wounds on branches or trunk. Dead twigs also offer a means of entrance, and there are probably other ways, not yet known, by which the trees become infected.

From the point of entrance the fungus spreads in all directions throughout the cambium and inner bark until it completely girdles the branch or trunk it has attacked. It has been found that a few of the outer annual rings of the wood are also attacked, and it is very likely that the fungus penetrates some of the medullary rays in search of the food material which they contain; but the real seat of the injury is the inner bark and the growing layer of the wood.

SYMPTOMS.

When a tree is first attacked the disease is not noticeable, and is likely to be overlooked. In many instances the trees are attacked first on the smaller branches. These are soon girdled, and the foliage turns yellow and then wilts. By these wilted branches the disease can be detected from a distance. The girdled branches or trees do not usually die until the second year, except when they are attacked very early in the season, or when the infected limbs are small.

On limbs with smooth bark the diseased patches are sunken and discolored, with small brownish or yellow knobs scattered over the surface. On the edge of the affected area in the growing season there is a ring of greenish, yellowish, or bright yellow excrescences which resemble horns and are very conspicuous, so that in young trees the disease is easily detected even before the branches wilt. In very dry weather, however, these horns may be nearly or entirely suppressed. Where the bark is thick, as on large trees, it is not changed in appearance, but the brownish knobs of the fruiting bodies show in the cracks, and the bark sounds hollow when struck.

On account of its rapid action in killing or wilting small branches, the disease can not remain long undetected if the trees are under inspection. At the end of a single year the disease has usually made its presence conspicuous by a large number of dead and dying trees.

LOCALITIES AFFECTED.

In 1905 the disease had already spread over a considerable area around New York City, where it apparently originated. In the present year it is spreading rapidly in a westerly direction over northern New Jersey, where in Morris County large tracts have recently been attacked. New York City is about the center of the infected area. Last year the chestnut tracts in Westchester and Nassau counties in New York, Fairfield County in Connecticut, and Bergen County in New Jersey were severely attacked, and now Morris, Essex, and Monmouth counties, N. J., can be added.

In Connecticut the disease is very severe at Stamford. It has been found near Danbury and Waterbury, and is known to extend along the coast to New London. It is also reported in southeastern Massachusetts and as far north as Wellesley.

On Long Island it is common in the western part and along the northern shore to Huntington. It is likely that it occurs on the island wherever there is chestnut, although it has not yet been reported from the eastern end. It extends up the Hudson to Poughkeepsie, and across the river to the west; it has been found, though not in great abundance, at Turner and Warwick, and has been reported at Marlborough. Near the Connecticut line it occurs as far north as Pawling and is very destructive from Katonah all the way southward to New York City.

In New Jersey the disease is very abundant in the northern and eastern parts, particularly near the coast in Bergen, Essex, and Monmouth counties. Southward it is found along the Delaware River to Trenton, and abundantly along the coast near Chapel Hill and Eatontown in the northern part of Monmouth County. Recently a belt around Morristown and German Valley has become badly infected, and the disease has been discovered in wild trees at Newark and Fenton, Del., and at various points near Philadelphia, Pa.

In Pennsylvania it is nowhere abundant yet, although it exists at Easton, South Bethlehem, and Morrisville, and is reported as far north as the Pocono Mountains and as far south now as Philadelphia. It has also been found near Baltimore, Md., and in Bedford County, Va.

The range at present, then, includes eight States: Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and Massachusetts. Pennsylvania, so far as known, is not infected to any great extent, except on the eastern border, while Massachusetts, Maryland, and Virginia are touched only at one or two points.

HOW THE DISEASE SPREADS.

The yellow fruiting bodies so common on the diseased trees are constantly giving off millions of summer spores all through the growing season. These are transported by various agencies to healthy trees, where they gain entrance through wounds in the bark. Wind is probably the principal agency, but the spores are no doubt carried by animals, birds, insects, and by shipment of infected material.

The disease spreads locally, through the gradual distribution of the spores from tree to tree, and at a distance, chiefly through the shipment of infected material, such as nursery stock, bark, nuts, and other products. There is a possibility that long distance infection is also effected by means of migratory birds.

There are a number of facts which support the view that the wind has been the principal agency in spreading the disease over the present area. For instance, trees in open spaces exposed to winds, such as those along roads, at the edges of woods, or near streams or ponds, are apt to be infected sooner than the trees in more sheltered situations; trees on slopes or in depressions with diseased trees on higher ground near them usually become infected, evidently because they have been exposed to the wind-scattered spores from above; and in thinned stands, if the disease is present in the neighborhood, almost every chestnut becomes affected. In this instance the frequency of wounds is probably a large contributory cause. Dense woods, as a rule, act as a bar to the progress of the infection, except where the disease is very prevalent in the vicinity, in which case nothing seems to check its spread.

AMOUNT OF DAMAGE.

The amount of loss caused by this disease is especially great, because it has developed in a region where the chestnut trees are extensively used for ornamental and park purposes. For this reason the losses have been acutely felt. There is, of course, no satisfactory basis for estimating the value of trees which are useful chiefly for æsthetic purposes, but the loss is certainly several million dollars.

In Prospect Park, Brooklyn, there are but 6 chestnut trees left alive out of 1,400. In Forest Park, at Jamaica, Long Island, practically all the chestnut trees are diseased and many are dead. The same applies to Bronx Park in New York City. In Nassau County, in western Long Island, few chestnut tracts have escaped serious damage. In Westchester County, N. Y., it is apparently only a question of a short time when nearly all the chestnuts will be destroyed. Many estates have sustained losses in scenic beauty which it is impossible to estimate. In the part of New Jersey adjacent to New York City the damage has been of the same character; parks and country estates have lost large numbers of fine chestnut trees which would not have been sold at any price.

Although so far the injury to ornamental trees has attracted the most attention, the damage is not confined to these alone. Indeed, a far more serious phase of the epidemic is the menace to commercial forest tracts. Already many large tracts in at least five States have been attacked, and though great damage has been done in certain localities, it is very small compared with what it will be if the disease continues to spread.

A favorable feature in the situation is that so far the disease has done most damage in the vicinity of the sea, and there are some indications that back from the sea, where there is less atmospheric moisture, it may be less virulent and may spread less rapidly.

The damage which would result from the destruction or extensive depreciation of the commercial chestnut forests would be many times that from the loss of ornamental trees. Chestnut is one of the most rapidly growing and most useful of American forest trees, and it plays a very important part in the forests of the eastern United States. The wood is exceedingly durable and has, therefore, been extensively used for posts, poles, and railroad ties, while its grain, color, and ease of working give it a place among furniture and finishing woods. It is, moreover, a very vigorous sprouter and lends itself admirably to forest management. With the exception of white pine, chestnut probably makes the most profitable timber crop that can be grown in the northeastern part of the United States.

UTILIZATION OF DEAD AND DISEASED TREES.

Since the fungus does not work in the wood to any extent and ceases its activities when the tree is dead, the wood is not damaged as a result of the disease. In many cases only a part of the tree is affected, while the rest is healthy and can be utilized without difficulty.

Dead trees are looked upon with suspicion, especially if they are killed by a disease, and the wood is popularly thought to be weaker than seasoned live timber. In the case of this fungus there is no

ground for such a prejudice; as a matter of fact, the dead material is fully as strong as any other timber if it is utilized within a few years, before the ordinary agencies of decay cause it to deteriorate.

In most of the places where the disease prevails the problem of cutting and marketing small amounts is a difficult one. The damage from the disease is sudden and it is often hard to find a market on short notice, especially for small quantities.

In order to market the material, owners should encourage the contractors and pole buyers, who as a class are also vitally interested in the perpetuation of the chestnut, to go into sections where the disease is doing damage. Where the tracts are large enough or several are located close together, a portable sawmill might be put in. Where the quantity of chestnut is small, the best disposal is for ties, cordwood, and fence posts. Owners of small tracts where the disease has appeared can often cooperate to great advantage in order to find a market or make a lumbering operation possible.

MEASURES OF PREVENTION.

The chestnut bark disease is not like ordinary fungous diseases which destroy a tree here and there after a number of years; it is even more virulent than the well-known pear blight, which it resembles in many particulars. It destroys quickly and spreads rapidly, and it is of the utmost importance to those who are interested in chestnut forests to secure a means of checking or stamping it out and of preventing its spread to localities which are as yet unaffected.

Seedlings and sprouts are attacked with equal virulence and old and young trees are killed alike. There is, therefore, no system of forestry which can be used to control the disease. Two methods of checking its spread and lessening the source of the infection are available:—

1. To cut out the diseased trees.
2. To institute a quarantine against the shipment of infected material.

In a forest tract the diseased trees should be cut outright—all trees which show the least sign of infection should be removed. In other situations, where the trees have a peculiar value, it may be possible to save them by cutting off the diseased parts only; but if the trunk of a tree is attacked, the whole tree, no matter how valuable it is, should be cut at once, for it is practically useless to try to save it.

Since the disease generally spreads less rapidly in dense stands than in thin ones, it will often be possible by close inspection and the prompt removal of infected trees to stamp out the disease altogether from a forest tract. For the same reason, however, if many diseased trees are to be removed and their removal would make the stand very open, it will often be better to make a clean cut of all the chestnut.

All diseased bark should be removed and burned. After that is done the wood is practically free from infection and can be used or stored with safety.

Even greater effort should be directed toward preventing the spread of the disease to localities which are as yet unaffected than to stamping it out in places where it already has a firm hold.

For this reason, definite legislation seems necessary, and it is very desirable that each State concerned should enact a law providing for a quarantine against infected chestnut products, chiefly nursery stock. The law should also provide for systematic and thorough inspection of the disease and require the cutting out of infected trees wherever they are a menace to healthy stands of chestnut.

The nature of the disease and the necessity of fighting it should be made known to the people throughout the region affected, by means of the press and by enlisting the aid of the granges and other organizations interested.

It is to be hoped that some natural limitation to the destructiveness of the disease may be found, and that it may be checked by natural causes. But its rapid spread and its great virulence make waiting dangerous. Prompt and energetic measures should be taken to stamp it out wherever it appears.

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FOREST EXTENSION IN THE MIDDLE WEST.

BY

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Assistant Superintendent of Tree Planting, Division of Forestry.

[REPRINT FROM YEARBOOK OF DEPARTMENT OF AGRICULTURE FOR 1900.]

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FOREST EXTENSION IN THE MIDDLE WEST.

By WILLIAM L. HALL,

Assistant Superintendent of Tree Planting, Division of Forestry.

INTRODUCTION.

There is no question but that a certain amount of forest planting on the prairies is profitable to the owner and helpful to the country. To what definite extent such planting can be carried with profit has not been and can not be demonstrated except by trial. Those who have studied the question most thoroughly and over the greatest area are convinced that extensive planting will be profitable, but their specific recommendations, both as to extent of planting and methods of procedure, have been local in scope and application. No system for general operations has been proposed.

It is the purpose of this article to go somewhat beyond local recommendations, and to show that the time has arrived for the extensive development of forest plantations throughout the Middle West, to indicate the sphere of general planting, and suggest a plan of procedure in carrying out the work.

Profit is the only basis upon which this system can be carried into effect, and the only inducement for attempting it. Before a man can be induced to plant trees with the aim of reaping a forest crop he must be convinced that such a crop, for the time it occupies the land, will be more profitable than any other. The growing of timber is an investment on much longer time than the growing of any ordinary crop. Money is invested which can not begin to give returns for several years. No one will begin such an investment unless he feels that, in the end, it will be more profitable than any series of short-time investments he could make.

PAST PLANTING.

Two facts are clear concerning Western plantations: First, there is a general aimlessness and lack of system in both planting and management; second, there is but a small percentage of thrifty plantations. In nine cases out of ten, planters have taken little thought to make their trees serve any definite purpose of utility. In localities where post timbers are scarce and dear, yards and fence rows have been filled

with trees of no practical value; where winds are terrific and almost constant, plantations have been established toward the quarter from which no winds blow; trees that thrive best close together are planted far apart; those that thrive in porous soils are unhappily placed on clay. It all shows that there is not yet an adequate conception of the value of forest trees and the purposes they can be made to serve. Some plantations, established with no thought of returns, have grown into considerable value on account of the posts, poles, and fuel they have produced; but these are exceptions.

A limited number of plantations have been established and developed for profit. Most of these are Catalpa plantations in Kansas and Nebraska. Locust (Black Locust), Black Walnut, and Ash have been much planted in these and adjoining States. Some Red Juniper (Red Cedar) has been planted in Nebraska and Iowa.

The majority of these plantations fall short of their maximum returns from lack of congenial soil or proper management, but some of them are striking exceptions to the general rule, revealing skill and wisdom in their conception, and giving promise of rich returns. A 10-year-old block in the Catalpa plantation of L. W. Yaggy, near Hutchinson, Kans., showed a net value of $197.55 per acre.[1] A 25-year-old plantation of Red Juniper of F. C. F. Schultz, near Menlo, Iowa, showed a net value of $200.54 per acre. Many other plantations showing the same values could be named. These equal or exceed the returns given by agricultural crops for such a period of years.

The value of the above-mentioned plantations proves conclusively that timber can be grown for certain uses in a comparatively short time, and that it has a high value when grown.

Past planting shows that the growing of forest trees is a profitable enterprise, but it also shows that the work must be begun and carried out with judgment and skill if satisfactory returns are to be had. No mere probabilities of soil or trees can be accepted; no slipshod methods can prevail. The same careful management must prevail in tree growing as is required in any other business.

We have ample experience from past operations to understand fully the conditions necessary for success. For more than twenty years planting has been carried on, under great diversity of soil, moisture, and temperature, with all kinds of trees, and by every sort of method. The results present every degree of variation from absolute failure to perfect success. A careful study of these experiences reveals in every locality the methods requisite to the successful development of plantations.

[1] The Division of Forestry has this year made extensive investigations in plantations of this character. The estimates here given are based upon actual measurements of the trees and present prices in the market.

THE PRESENT TIME PROPITIOUS FOR FOREST PLANTING.

The diminution of natural timber in the Mississippi Valley has been general. On the eastern side the destruction of forests has been greatest because there the supply was greatest. The valley of the Wabash River is now cleared in most places to the banks of the stream. A prominent farmer of Vigo County, Ind., told the writer recently that he had but a half dozen remaining white oaks to use for posts, and that he would soon have to grow his own posts or buy them. That this sentiment is prevailing throughout Indiana, is shown by the fact that the Division of Forestry has been called upon this year to make plans for the planting of a number of tracts of timber of from 5 to 50 acres each in different parts of the State.

On the west side of the Mississippi a condition of greater scarcity prevails. Little timber is left in western Iowa and Missouri. The valleys of eastern Kansas, which produced large quantities of Black Walnut and Bur Oak, have largely been cleared. (Pl. XII, fig. 1.) Arkansas holds the greatest supply of valuable timber in the Middle West, but it is filled with sawmills, many of them of immense capacity, running day and night. The most valuable post and tie timbers of Arkansas are White Oak and Bur Oak, the supply of which is rapidly diminishing. There yet remains a remnant of Red Juniper in southwest Missouri and eastern Indian Territory, but it can scarcely last a dozen years longer, as the regions are now penetrated by railroads, and it is being shipped out as fast as it can be cut. Originally, the Red Juniper grew in considerable abundance in northwest Oklahoma along the Canadian and Cimarron rivers. A few years ago posts could be bought for 4 or 5 cents each. The supply is exhausted, and at the present time but a few posts can be obtained at even 12 or 15 cents each. The Red Juniper of the Platte Valley in Nebraska has gone in the same way. No natural supply from either of these regions need be reckoned on in the future. Osage Orange as a native timber is exhausted.

The consequence of this diminution of post, pole, and tie timber has been a general rise in prices. Good fence posts are now selling throughout the region at from 10 to 20 cents each. Ten years ago they could be bought at from 8 to 12 cents. Telegraph and telephone poles are worth 50 per cent more now than twenty years ago, and railroad cross-ties 25 per cent more. In the Great Plains, where there was no natural timber, prices have always been high and are now not much higher than ten or twenty years ago.

On extensive areas of the Great Plains and the Mississippi Valley, prices of posts, telegraph poles, and cross-ties much exceed the cost of growing them. This difference promises profit in timber growing. While prices are high enough for profits under present conditions, yet conditions are bound to improve. Every year finds the natural timber

supply scarcer and prices higher. Mr. J. Hope Sutor, general manager of the Ohio and Little Kanawha Railroad, after giving the matter careful consideration, estimates the value of a cross-tie fifteen years hence at 75 cents. Mr. Sutor also says "no material has yet been found as a substitute for the wooden tie, and no satisfactory economical method of preserving the life of the wood or prolonging its durability has yet been discovered; and, excepting the minor questions of properly seasoning and piling, the use of the tie plate, suitable ballast and perfect drainage, and incidentally climatic conditions, no serious consideration of the future tie supply has yet been had."[1]

What is here said of cross-ties is true of all other timbers used in contact with the ground. While no metallic substitute has been found, their durability has not been greatly prolonged. The use of these materials must continue and will grow rather than diminish. Mr. Sutor's estimate of 75 cents for a cross-tie fifteen years in the future allows for an increase of about 50 per cent over present prices. This is a conservative estimate, and it is not unlikely that posts will increase as much and telegraph poles much more in that time.

From every reasonable point of view, it appears that great profits are to be made in the growing of forest trees in the next twenty-five years. Every condition is so favorable that the matter passes from probability to certainty. That operations should begin in the Middle West rather than in other regions is due to the fact that there the most favorable conditions exist; there the supply of natural products is most nearly exhausted, prices are highest, soil most fertile, and people most familiar with the processes of developing plantations. Operations will not progress far in that region before they begin in regions of the extreme East and West.

SPHERE OF GENERAL PLANTING.

It is necessary in this connection to point out the purposes for which timber may be grown, the sections for successful operations, and the extent to which planting may safely be carried. While it is easy to go from fact to assumption on such a theme, yet the argument goes no further than to cover such simple operations as we may be positive about, in regions of which we have personal acquaintance.

PURPOSES FOR WHICH TIMBER MAY BE GROWN.

FENCE POSTS.—The timbers best suited for this purpose are Osage Orange, Locust, Hardy Catalpa, Red Juniper, Mulberry, Black Walnut, Oak, and Ash.

Osage Orange posts have been obtained from native timber and from old hedge rows, mostly from the latter source. This tree has been used

[1] Address delivered at the July meeting of the Central Association of Railroad Officers at Louisville, Ky., and published in the Railway Age, July 27, 1900.

Yearbook U. S. Dept. of Agriculture, 1900.

FIG. 1.—NATURAL BLACK WALNUT AMONG GREEN ASH AND HACKBERRY. VALLEY OF VERDIGRIS RIVER, WILSON COUNTY KANS

FIG. 2.—HARDY CATALPA, WIDE PLANTED, SHOWING RESULTS IN CROOKED, MUCH-BRANCHED TRUNKS. NEOSHO COUNTY, KANS.

Yearbook U. S. Dept. of Agriculture, 1900.

FIG. 1.—FOURTEEN-YEAR-OLD HARDY CATALPA, BEING GROWN FOR TELEGRAPH POLES. PLANTATION OF GEORGE M. MUNGER, GREENWOOD COUNTY, KANS.

FIG. 2.—THIRTEEN-YEAR-OLD BLACK WALNUT, GROWN FOR POSTS. THE WIDE PLANTING HAS RESULTED IN LOW BRANCHING. COMANCHE COUNTY, KANS.

FIG. 1.—FOURTEEN-YEAR-OLD HARDY CATALPA, BEING GROWN FOR TELEGRAPH POLES. PLANTATION OF GEORGE M. MUNGER, GREENWOOD COUNTY, KANS.

FIG. 2.—THIRTEEN-YEAR-OLD BLACK WALNUT, GROWN FOR POSTS. THE WIDE PLANTING HAS RESULTED IN LOW BRANCHING. COMANCHE COUNTY, KANS.

extensively as a hedge plant in eastern Kansas, Missouri, Iowa, and Illinois. Hedge rows sometimes turn out as many as 25 posts to the rod. It has seldom been planted except in this way, but will grow well in plantations. Its durability in contact with the soil is greater than that of any other wood commonly used, and it justly ranks high as a post timber. It requires from twelve to fifteen years to reach suitable size for posts.

Locust (Black Locust) is a well-known post timber. It grows rapidly, is well adapted to hard, stiff soils, and stands more drought than any other timber used for posts. These properties make it very popular in many parts of the West.

The Hardy Catalpa has been more abundantly planted as a post timber than any other tree. It is especially popular, and deservingly so, in eastern Kansas and Nebraska, where several large plantations have been made. It does best on deep, porous soils. Its durability in the ground has probably been overestimated by some but not fully appreciated by the public generally. When cut at the proper season its durability nearly equals that of the Osage Orange, but if young wood be cut when full of sap it is subject to attack by a fungus which destroys it rapidly. If to its durability we add its rapid growth, good form, lightness, strength, elasticity, immunity from checking or becoming unduly hard, we have an array of good qualities that to many men of experience place it first among post timbers. It requires from eight to twelve years to become large enough for use.

Red Juniper (Red Cedar) is a durable and valuable post timber, commanding good prices everywhere. Its main drawback is its slow growth, and it may never become popular as a domestic post timber except in limited areas. Twelve or fifteen years are required to grow it.

Mulberry, especially the Russian type, has made a good record in some sections of the West. It grows rapidly, is usually more or less crooked, but lasts well in the ground. It does best in porous, sandy soils, and when grown thickly in the row. It can be used in ten years after planting.

Black Walnut posts are used extensively in some localities. Posts from the old wood last a long time, but those from the young wood soon decay. It is of slower growth than Catalpa and Locust. (Pl. XIII, fig. 2.)

Oak, principally White Oak, Bur Oak, and Post Oak, has furnished more posts in the past than any other timber, the native trees being used. As the supply is exhausted in various sections its use will largely cease; it grows too slowly to be planted extensively.

Ash, principally White Ash and Green Ash, has been planted throughout northern Nebraska and South Dakota. Its growth is rather slow, from twelve to fifteen years being required to produce a post of

good size. Its life in the ground is quite satisfactory, and for the region it seems to be the best post timber.

The use of posts is now enormous, and on the increase. Fences requiring them are the only kind now being established in this region. No rail fences are being built, and no hedges planted, except a few in Oklahoma. This being true, a very great demand for posts must ensue and continue from year to year. Since posts sell for higher prices in regions remote from natural timber, on account of added transportation costs, it follows that such regions are the best in which to have an available supply, and, if the conditions are favorable to the growth of timber, plantations will there prove most profitable. But in ten or fifteen years many regions which now have an abundant supply will show a scarcity, and prices will be high, so that in such localities it would be profitable to be planting timber even now.

TELEGRAPH, TELEPHONE, AND ELECTRIC POWER AND LIGHT POLES.—The timbers most used for these purposes are Tamarack, White Cedar, and Red Juniper. Their value is fully known, and if the supply could hold out nothing would displace them. Their life in the ground is about ten years, so that every decade sees one generation of poles worn out and another cut to replace it. To the poles required for renewal is to be added the number required for new lines and systems. The total is very large. The telegraph lines of the country require nearly 600,000 poles annually, at a cost of not less than a million dollars, and the telephone and electric car lines and light systems use as many more. The price of poles for such uses varies immensely, ranging from $1 to $50 each. If an advance in the price of post timbers is to be expected in the next fifteen years, a much greater advance may be expected in timbers of this class. A post may be grown comparatively quickly, and in an exigency almost anything can be used; but a telegraph pole must be long, straight, and of good quality. Timbers that fulfill these conditions are few, and a number of years are required to grow them. When the natural supply runs low, high prices will prevail. The man will be fortunate, then, who has a plantation of salable Red Juniper or Catalpa. Here again the Catalpa will show its excellence.

RAILROAD CROSS-TIES.—The timbers most in use for this purpose at the present time are White Oak, Post Oak, Bur Oak, White Cedar, Red Juniper, and Chestnut, with White Oak preferred. Prices range from 30 to 60 cents each for standard sizes; 620,000,000 cross-ties are in use in the railroads of the country and 90,000,000 are required annually for renewals, taking the timber from an estimated area of 200,000 acres. Railroad officials realize that tie timber is becoming scarce, and assert that prices are rising rapidly. Street car and suburban lines are now using many million feet of lumber for cross-ties.

It is certain that timber can be grown for railroad ties at a profit.

FIG. 1.—TWENTY-YEAR-OLD HARDY CATALPA APPROACHING SUITABLE SIZE FOR TELEGRAPH POLES. PLANTATION OF KANSAS CITY, FORT SCOTT AND MEMPHIS RAILROAD COMPANY. CRAWFORD COUNTY, KANS.

FIG. 2.—GROWTH OF PLANTED TREES IN THE ARKANSAS RIVER VALLEY. A SECTION WELL ADAPTED TO FOREST TREES.

Two extensive plantations of Catalpa at Farlington, Kans., established twenty years ago, have now some trees large enough for ties. The soil of the locality is not well suited to the Catalpa, and the management of the plantation has not been the best. Hardy Catalpa and Locust can be grown to the proper size for cross-ties in fifteen years under favorable conditions of soil and management. Only in certain localities of the West will the Oaks be planted for this purpose. The White Oak requires thirty or forty years to make the growth that the Hardy Catalpa makes in fifteen, whereas it is generally conceded that there is little difference in their value as tie timbers.

GENERAL LUMBER PURPOSES.—When timber is large enough for cross-ties it is approaching readiness for other uses. There will always be great demand for this class of lumber for use in furniture, cars, implements, and vehicles. Whether it will be profitable to hold plantations for these uses rather than to sell them for the uses mentioned can not as yet be determined. (Pl. XIV.)

SECTIONS OF SUCCESSFUL OPERATIONS.

Two features must characterize the sections of the country that permit of successful work in forest growing: First, the natural conditions must be congenial to the species used; second, the section must lie in or near a territory of good demand.

SPECIES AND SECTIONS ADAPTED FOR PROFITABLE PLANTING.—It is generally known that each of the species named above thrives best only in certain sections, and it has already been stated that the demand is greater and prices higher in some sections than in others. The attempt is made below to point out for each of the species mentioned the sections in which these two requirements are to be met. Some localities are omitted on account of minor area, others on account of lack of information concerning them, still others because one of the two requirements is not present, and only those which can be recommended with absolute assurance are mentioned for each species.

Osage Orange.—Valleys of the Red River, tributaries, and adjacent lowlands from western Arkansas to central Oklahoma; valleys of streams in eastern Indian Territory, eastern Kansas, and western Missouri.

Locust (*Black Locust*).—Oklahoma, Indian Territory, southern Kansas to Arkansas River, uplands of eastern Kansas and western Missouri; also hillsides of southern Indiana and Ohio.

Hardy Catalpa.—Valley of Arkansas River from west line of Arkansas to Garden City, Kans.; valleys of other streams in central and eastern Kansas and Nebraska to Platte River; southern Iowa in localities having porous subsoil; also southern Illinois and western Indiana. The Wabash River Valley is especially favorable.

Red Juniper (Red Cedar).—Valley of the Platte River, eastern Nebraska, eastern third of South Dakota, central, western, and northern Iowa, hillsides of southern Ohio, portions of southwest Missouri.

Russian Mulberry.—Sandy valleys of central Oklahoma, central Kansas, and southern part of central Nebraska.

Black Walnut.—Valleys with rich, deep, well-drained soil in eastern Kansas, Missouri, eastern Nebraska, southern Iowa; also valleys of Wabash and Kankakee rivers in Illinois and Indiana.

Bur Oak.—Valleys of Niobrara and Missouri rivers in Nebraska and South Dakota; immediate vicinity of Devils Lake, N. Dak.; also valley of the Red River of the North.

Post Oak and White Oak.—On waste land of gravelly or sandy nature in eastern Oklahoma, Indian Territory, western Arkansas, and on the same sort of land in Illinois, Indiana, and Ohio.

Ash (Green Ash and White Ash).—Northern Nebraska, eastern South Dakota, southeastern North Dakota, southwestern Minnesota, and western Iowa.

Tamarack.—Lake and swamp district of Turtle Mountains, North Dakota; marsh districts of Minnesota, Wisconsin, and Michigan. Not likely to succeed where marshes have been drained in northern Illinois and Indiana.

Of the trees considered, the Hardy Catalpa has better prospects for success, in its section, than any other. This is due to the ease with which it can be managed, its rapid growth, and its adaptability to a large category of uses. That it thrives in but a limited section is to be regretted. Nevertheless, its territory is large enough for great quantities of it to be produced.

VALUABLE TREES OTHER THAN THOSE MENTIONED ABOVE.—It is freely admitted that there are many trees valuable for planting in the Middle West not included among those given above. All the Elms, Maples, Poplars, and Willows are omitted, and the writer knows well that they have a high silvicultural value; but in a system of forest operations instituted for profit and carried on under competition, such trees can as yet have little place. They have been widely planted and will continue to be planted for shade, shelter, and ornament, but not for profit. In their influence upon the country they have a high value, and as a class they are not to be lost sight of or disregarded in forest planting; but since this article concerns itself only with those elements that lend themselves readily to the immediate extension of forest operations, a general discussion of these trees is not included.

EXTENT TO WHICH PLANTING MAY BE CARRIED.

The area for profitable tree planting ten years ago was thought to be limited to the Great Plains. It extends now to sections in the entire

Middle West. Since the profits of timber growing have become manifest, people have become imbued with the tree-planting spirit. There will be more trees planted in the spring of 1901 than have ever been planted before in a single year, but the number to be planted will fall short of the number required. If 500,000 acres of timber should be planted annually, well distributed throughout the Middle West, the production would yet be inadequate to meet the requirements of the country, and the planters could still hope for liberal profits. Ultimately this figure will no doubt be reached.

METHODS OF PROCEDURE.

PLANTATIONS ALREADY ESTABLISHED.

The area of planted timber in the Middle West aggregates many hundred thousand acres. Some of this timber is on the decline, some at its best, and some growing into greater value each year. To the last class belong most of the plantations made for profit. Notable among these are the large Catalpa plantations of central and eastern Kansas.

Nearly all of these plantations were established and maintained at first by careful and businesslike methods in the hands of skillful men. Such methods were continued three or four years, and, the young forests well established, the owners thought the battle won and remitted their attentions. The time came for thinning, but it was not done. The trees struggled with one another, and some of the most vigorous managed to thin for themselves by killing their neighbors, but at a great expense to their own growth and vitality. This is true of several of the well-known plantations. They need judicious thinning under the immediate direction of one who fully understands forest operations. Their management from this time on may make a difference of thousands of dollars in their returns. It would be an act of wisdom on the part of the owners to seek the advice of practical foresters in the future management of these plantations.

A large number of plantations have been established within the last three years. From these, excellent returns may be expected, for in almost every case they are in the hands of men who appreciate their importance and know how to manage them properly for the object in view.

Within the last year nearly one hundred plantations have been established in cooperation with the Division of Forestry under its plan of practical assistance to tree planters. In each case an expert of the Division has made an examination of the land, and, after consulting the owner on the objects to be attained, has prepared a plan for the establishment and management of the plantation. Profit has not been the sole object in all cases, but it is a leading feature in nearly all. The Division will direct the management of these plantations from

year to year, and it is believed to be possible in this way to make them fully successful and profitable to their owners. Most of them are small, ranging from 5 to 50 acres, but many will be extended over larger areas in the future. (Pl. XV.)

FUTURE PLANTATIONS.

It may be expected that the plantations to be first established will be small. On individual farms such tracts will be planted to timber as can be spared from annual crops, usually from 5 to 20 acres. Sometimes men of large farms and ample means will afforest 100 acres or more. Larger operations than can be handled with ease and thoroughness should not be attempted. The main object of such plantations should be the production of materials required on the farm and in the immediate locality.

While operations will be carried on generally in small plantations, the time has come when men of means can get large returns from the development of plantations on extended areas. There are reasons for believing that the work can be carried on more successfully by companies than by individuals. The long-time nature of the investment adapts it more especially to company control. The life of a company is permanent, while the life of an individual may cease at any time and throw the investment into hands that fail to carry it out. Companies are also likely to operate on a larger scale than individuals, and large operations will give better returns than small ones. All plantations of this class should be extensive enough to warrant the permanent employment of a resident forester of skill and ability, and should be carried on in sections most suitable to the work. To find such sections is the first step, to fail in which is to fail utterly.

RAILROAD PLANTING.

The question arises, Since the railroads will be large consumers of timbers that will have to be grown, why should they not establish plantations along their lines? The question has been considered by a number of companies, and operations have been attempted by a few. There is no reason why they should not undertake the work and carry it out successfully. Most of them hold land that is well adapted to forest trees, and by planting tracts of sufficient size to meet their demands, they will greatly reduce their future expenses. It is as practicable for railroads to produce their own timber as it is to mine the coal they use.

WORKING SYSTEM.

While men may be convinced of the profits in forest plantations, those not familiar with their nature and requirements will find many obstacles to surmount if they attempt, unaided, the work of developing them. The subject is yet too new for men generally to have given

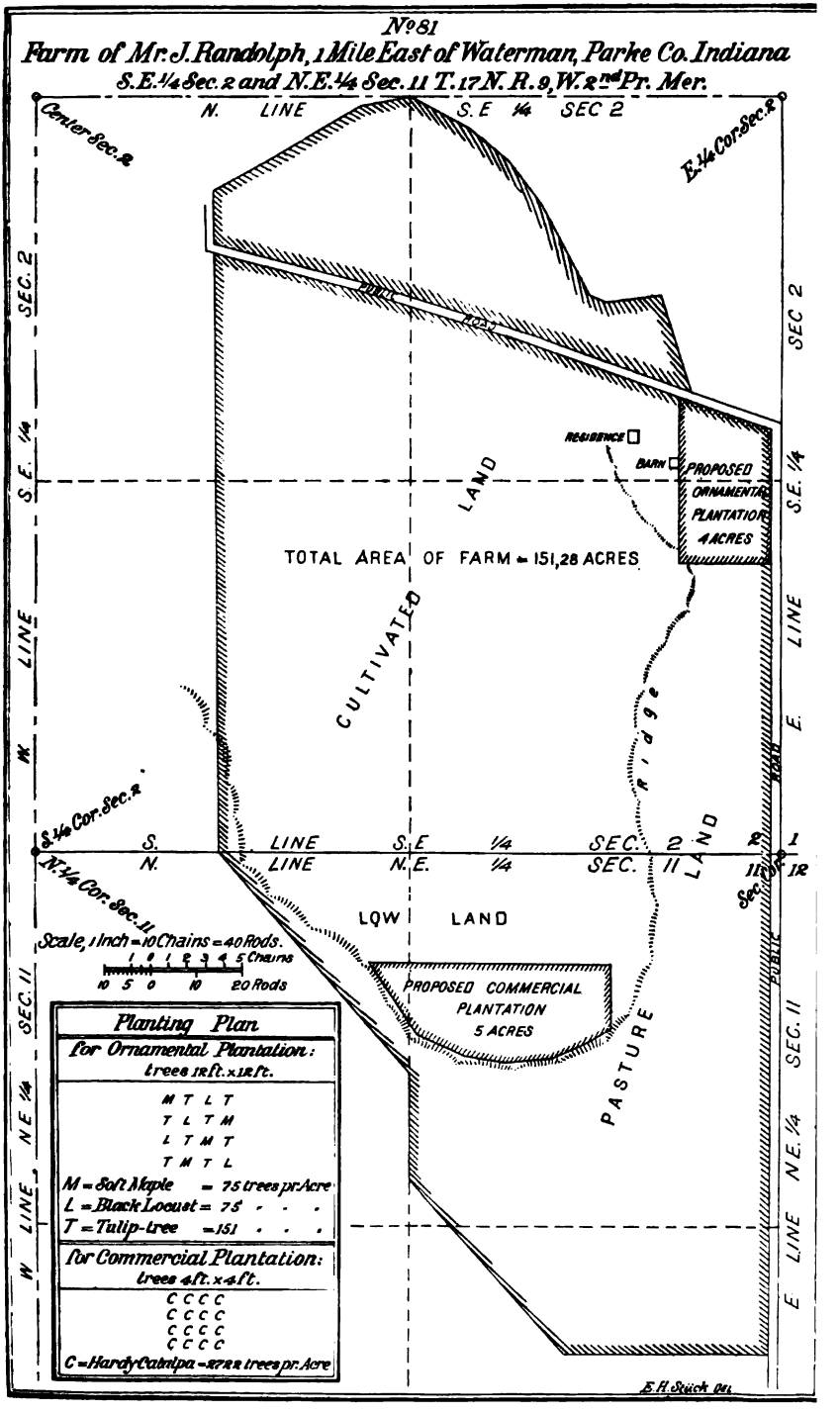

DIAGRAM SHOWING A REPRESENTATIVE PLANTING PLAN FOR A SMALL FARM.

it thorough and exhaustive study. Even farmers have no clear conception of the adaptations of trees to soils or to particular sections of the country, and very few seem fully to understand the best methods of developing a forest plantation. For the individual, these are difficult subjects, requiring both study and travel, but what is difficult for the individual in this case is easy for the Government, which, through the Division of Forestry, can readily investigate the entire subject and determine such matters as sections of adaptation, kinds of trees to be used, and soils and methods best adapted to each species. It is appropriate that this information be supplied free of charge to the person entering upon forest operations, and to this end the Division of Forestry instituted the plan of practical assistance to tree planters. Its purpose from the first has been "to give such aid to planters that wood lots, shelter belts, wind-breaks, and all other economic plantations of forest trees may be so well established and cared for as to attain their greatest usefulness and most permanent value to their owners."

Under the provisions of this plan, the farms of applicants are visited and examined by an expert of the Division, who makes a careful investigation of all conditions affecting tree growth. A planting plan is then prepared for the owner upon the basis of local conditions and requirements. The plan embodies complete and detailed instructions concerning the location, establishment, and management of the plantation. In no case does the Division furnish seeds or trees, or participate in any degree in the expenses of planting and caring for the plantation, but the visit of inspection is always free, and the planting plan is usually without cost to the planter.

GENERAL RESULTS OF THE COOPERATIVE PLAN.

A careful study of the conditions of the country in connection with this work is convincing that the time is at hand for great extension of timber growing by reason of the returns to be received from it. The sphere for planting is extensive and profits, under good methods, are certain. At the same time the Division of Forestry is able to give more efficient service than in the past, on account of more extensive study of the conditions, needs, and possibilities of the country. It stands ready to advise on choice of soils and kinds of trees, on local obstacles or advantages likely to affect success; to give opinions and advice on lines of forestry that have greatest prospect of profit, as well as to point out regions where such lines can be most propitiously carried out, and to prepare planting plans embodying methods to be followed in the establishment and management of such plantations.

That planters will continue to seek Government cooperation is assured by the great favor which the work is meeting. The visit of the expert forester to an applicant usually has a salutary influence

upon the entire community in which he lives. Frequently several plans are made in a community where but one was anticipated. It seems reasonable to hope that the influence of the Division may be thus extended to almost every locality where trees can be profitably grown. Its influence will be not only that of stimulation, but of regulation and direction as well, in all planting operations.

From such a system of forestry will arise maximum returns to the individual and greatest benefits to the community concerned. At the same time the people will become educated to a higher appreciation of the value of forests, and the country at large will gain a unique and valuable accession to its forest system.

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FOREST ...
Issued January ..., 1914.
COLLEGE OF ... AGRICULT...
UNIVERSITY OF CALIFO...

United States Department of Agriculture.

FOREST SERVICE.

HENRY S. GRAVES, Forester.

FOREST FIRE PROTECTION BY THE STATES

AS DESCRIBED BY REPRESENTATIVE MEN AT THE WEEKS LAW FOREST FIRE CONFERENCE.

Edited by J. GIRVIN PETERS,
Chief of State Cooperation, Forest Service.

PURPOSE OF THE CONFERENCE.

On January 9 and 10, 1913, there was held at the Forest Service, Washington, D. C., a conference of forest officials of States with which the Federal Government is cooperating in the protection from fire of the forested watersheds of navigable streams under the provisions of section 2 of the Weeks law, forest officials of other States, representatives of timberland owners' protective associations and forestry associations, private foresters, and others interested in forestry, in addition to members of the Forest Service charged with the administration of section 2 of the Weeks law.[1]

The States represented include all of New England, New York, New Jersey, Pennsylvania, Maryland, Virginia, West Virginia, North Carolina, Ohio, Michigan, Minnesota, and those of the Pacific Northwest. Those States with which the Federal Government has cooperated under the law are Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, New Jersey, Maryland, Wisconsin, Minnesota, Washington, and Oregon. The heads of the fire protective systems of these States, in addition to the chief fire wardens of certain timberland owners protective associations, hold Forest Service appointments as collaborators.

The objects of this conference were (1) to provide for an informal discussion of the administration of the law and of the various methods of fire prevention which have been adopted by the States, (2) to determine the results of the cooperation, and (3) to encourage States which can not fulfill the requirements of the law to enact legislation enabling them to do so.

[1] A roster of attendance is given in the Appendix, p. 77.

The most striking feature of the conference was the tremendous emphasis placed on the value of cooperation between all protective agencies and of educating the public in general of the need of preventing forest fires.

H. S. GRAVES, Forester, United States Department of Agriculture, opened the conference with the following address:

THE POLICY OF THE FEDERAL GOVERNMENT IN ASSISTING STATES TO PROTECT THE FORESTED WATERSHEDS OF NAVIGABLE STREAMS.

GENTLEMEN: We have called this conference to discuss that section of the Weeks law authorizing cooperation by the Federal Government with the State in protecting from fire the forests situated on the watersheds of navigable streams. We have before us for consideration not only the details of carrying out this law, but also the results which have already been accomplished as bearing on the wisdom of the appropriation which has been made and the desirability of extending the policy through subsequent appropriations by Congress.

The appropriation of $200,000 for Federal assistance in fire protection initiated a new policy. When the Weeks law was under consideration it was maintained by some persons that greater results from a given expenditure of money would be accomplished by annual appropriations to aid the States in fire protection than by the establishment of National Forests by purchase. The appropriation of $200,000 was, in a way, an experiment to test the efficacy of this kind of Federal aid. While making this appropriation, Congress at the same time adopted the policy of acquiring National Forests in the eastern mountains where none had existed. It recognized, however, that this appropriation or any other which might be made later on would not be large enough to acquire all of the mountain areas which ought to be under public control, or at least to acquire them within such period as would enable the establishment of public control in time to accomplish the purposes of forest protection. There was recognition of the principle that there is a national interest in these great areas of forest lands, and that there is not only a justification but a duty on the part of the Federal Government to see to it that these national interests are protected.

It is unnecessary for me to emphasize the importance of forestry from the public standpoint. It is unnecessary for me to repeat that the public must not permit the forests to be handled in a way to result in direct public injury by the effect on water resources or indirect injury through the stoppage of forest production. I do wish, however, to make the point that these public interests are in a great many cases not confined to the State in which the forests lie. There are many problems of forestry involving interstate considerations in which our Federal Government can not participate on account of constitutional limitations, or at least unless there is a different interpretation of these limitations than heretofore has been made. For example, a State which has under consideration the making of certain requirements on private owners in the matter of fire protection, or

perhaps in the methods of cutting in order to bring about better practice of forestry, immediately meets the difficulty that the operators, on account of increased cost of logging, are placed at a disadvantage in competition with those of other States where no such restrictions exist. The reason for this trouble is that the products of the forest go into the general market, and so far it has been exceedingly difficult to secure uniform State laws which are really effective in meeting the requirements of our problem.

The discussion of the new policy of acquisition of National Forests in the East early brought out the fact that in stream protection the States are helpless where the streams flow from one State into another. A given State will not make large expenditures for public benefits which inure primarily to the people of another State. It was decided by Congress that it was unconstitutional to purchase forest lands merely to produce timber and for certain other public benefits which were fully recognized as having an interstate character. I think the debates during that time show clearly that nearly every one recognized the interstate character of a great many of these problems, in addition to the navigable feature.

In administering the cooperative clause of the Weeks law the Forest Service has clearly in mind the principles which I have indicated. It has been the effort so to distribute the money that it would last through about three seasons and to expend it under sufficiently diversified conditions to insure conclusive results.

The question comes before us now of what has been accomplished during the two seasons of cooperation which have already passed. Has it resulted in the stimulus to the States to meet their responsibility in forestry? Has it resulted in securing better protection than otherwise would have been the case of the forests on navigable streams; and if so, have the results from this standpoint alone justified the expenditures of the $200,000? In securing such protection, have other national and interstate interests been secured aside from mere protection to navigation? In short, before we go to Congress and request an extension of this appropriation we must be able to show that this new policy, which was in a measure inaugurated as an experiment, has produced certain definite results which justify the nation in continuing the work.

I want to emphasize over and over again this national feature of the work, because we are asking the National Government to provide the money, and while the protection of navigation is the constitutional reason for the appropriation, the general national and interstate interests are a tremendous additional justification. I think that was fully recognized by Congress when it passed the law, if I may judge by my interpretation of the records of the debates and by my discussion of the whole subject with the men who were responsible for putting this measure through Congress.

Mr. Peters has many facts which demonstrate to my mind that the results obtained are of an importance even greater than could have been anticipated. We want to know, and Congress wants to know, what the experience has been in the States, both from the viewpoint of the State and from that of the Nation.

TABLE 1.—*Cooperative fire protection with States under section 2 of the Weeks law, basis of allotment of Federal funds, calendar year 1913.*

State.	Total area of State.	Net area of National Forests in State (protected by the Federal Government).	Approximate area of State and private lands.		Last annual appropriation by State for forest fire protection.	Amount available for expenditure per acre by State on area actually protected (including cooperative watersheds).	Cooperative watershed protection (exclusive of Federal lands within National Forests).				
			Requiring protection.	Actually protected by State.			Approximate area of watersheds requiring protection.	Amount available for expenditure per acre in a favorable season by private protective associations.	Federal allotment, 1913.[a]	Amount available for expenditure per acre by—	
										Federal Government.	Federal Government, State, and private protective associations.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Acres.	*Acres.*	*Acres.*	*Acres.*			*Acres.*				
Maine	19,132,800		15,000,000	[b] 9,500,000	[c] $67,900	$0.007	[b] 6,000,000		$8,000	[b] $0.001	$0.008
New Hampshire	5,779,840		4,000,000	Entire area.	16,000	.004	4,000,000	[d] $0.004	6,000	.002	[e].010
Vermont	5,839,360		3,000,000	Entire area.	3,500	.001	1,500,000		1,500	.001	.002
Massachusetts	5,144,960		2,500,000	Entire area.	25,000	.010	1,250,000		2,500	.002	.012
Connecticut	3,084,800		1,500,000	Entire area.	2,000	.001	750,000		1,500	.002	.003
New York	30,498,560		12,000,000	[f] 7,200,000	75,000	.010	7,200,000		7,000	[f].001	.011
New Jersey	4,808,960		2,500,000	Entire area.	15,000	.006	1,000,000		2,000	.002	.008
Maryland	6,362,240		3,000,000	Entire area.	4,000	.001	1,000,000		2,000	.002	.003
Kentucky	27,715,840		15,000,000	Entire area.	5,000	.0003	10,000,000		4,000	.0004	.001
Wisconsin	35,363,840		15,000,000	Entire area.	35,000	.002	1,250,000		5,000	.004	[g].019
Minnesota	51,749,120	800,000	27,000,000	20,000,000	75,000	.004	18,000,000		8,000	.0004	.004
Montana	93,296,640	16,000,000	3,000,000	1,700,000	[h] 3,500	.002	1,700,000	.010	3,500	.002	.014
Idaho	53,618,560	18,000,000	6,000,000	4,000,000	15,000	.004	6,000,000	[i].026	7,000	.001	[j].031
Washington	42,775,040	10,000,000	15,000,000	Entire area.	38,000	.003	5,000,000	.017	8,000	.002	.022
Oregon	61,188,480	14,000,000	15,000,000	Entire area.	30,000	.002	10,000,000	.010	8,000	.001	.013
Total									74,000		

[a] All expenditures will be for the salaries of lookout watchmen in the Maine forestry district, in Massachusetts, and in the forest preserve counties in New York; 25 per cent in the three northern districts of New Hampshire, and 100 per cent in the southern district; and 25 per cent each in Connecticut and New Jersey. In Maine, not to exceed $6,000 is available for expenditure in the forestry district; in New York, not to exceed $4,000 in the forest preserve counties; and in Idaho, not to exceed $4,000 in the panhandle.

[b] Maine forestry district.

[c] State appropriation is obtained from a timberland tax.

[d] In the three northern districts.

[e] In the three northern districts $0.01; in the southern district $0.006.

[f] Forest preserve counties.

[g] State expenditure on the cooperative watersheds is $0.015 per acre.

[h] Available from land-grant income funds.

[i] In the panhandle.

[j] In the panhandle, $0.031; outside the panhandle, $0.005.

Mr. HUTCHINSON. May I ask why Pennsylvania has received no Federal allotment for fire protection?

Mr. PETERS. Pennsylvania has never requested one. I think there is no question that the State can fulfill the requirements of the law.

I wish now to take up the expenditure of Federal funds. In order to simplify the fiscal operation of the law and the inspection of the work, we have limited the expenditure of Federal funds to the salaries of lookout watchmen and patrolmen, preferably the former. It is felt that where lookout stations are feasible they constitute one of the most effective means of fire prevention; moreover, in many cases the watchmen are on continuous duty throughout the fire season, and thus expenditures limited to their salaries tend still further to simplify the cooperation. It is for these reasons primarily that this limitation has been imposed wherever it has been possible and practicable to do so.

Mr. COX. I hope this policy of limiting the expenditures to the employment of lookout watchmen only will not be extended to include the whole of the cooperative territory, because in Minnesota it will only work well in the northeastern part of the State, which is a mountainous country, where the conditions are practically the same as in the Adirondacks in New York. In northern and western Minnesota, however, the conditions are very different, the country being fairly level. Fire protection there must be done by patrol on an extensive scale. The protective force has a large territory to cover, and the men have to keep on the move; they have to hunt for the fires, which, as a rule, do not spread rapidly. Generally, fires can not be seen far enough off from a lookout for it to be effective even if a man is stationed there permanently.

Mr. PETERS. I am glad you brought up that point, because it raises the question as to why we include some sections of country and exclude others. Our policy has been to limit Federal expenditures to the salaries of lookout watchmen only in country whose topography is such as to make the establishment of lookout stations practicable, provided at the same time the effectiveness of the State's protective plan is not lowered by such limitation. It has worked no hardship in some States—for example, as Maine, Massachusetts, and New York. In others, where the establishment of lookout stations on a comprehensive scale has not been possible, the restriction has been imposed only in part. In Connecticut and New Jersey but 25 per cent of the Federal expenditures will be for watchmen's salaries. In New Hampshire a unique situation exists, in that a special appropriation is made by the State for the maintenance of lookout stations, and it can not be used for any other purpose. For this reason, although the northern part of the State is covered by an extensive system of lookouts, we have estimated that but 25 per cent of the Federal expenditures would be a fair proportion to require the State to devote to watchmen's salaries. In Vermont the law practically makes the State itself liable for all watchmen's salaries.

In the States where protective work on a comprehensive scale is just being started, as, for example, in Maryland and Kentucky, we would not be justified in limiting the Federal expenditures to the salaries of lookout watchmen; and in the Lake States and the Pacific Northwest the topography is such that lookout stations equipped for

continuous operation are usually not practicable. However, while the restriction is not being imposed upon these States, we are requesting our collaborators to place on the Federal pay roll the lookout watchmen employed on the cooperative watersheds.

Mr. ELLIOTT. In Oregon we are equipping some of our lookouts with telephones, and we expect to keep the patrolmen on these lookouts as much as possible, but we, of course, want to be able to use the men on trail or patrol work whenever it becomes desirable to do so. We would not want to be restricted as regards their employment in a year like the past one, which was very favorable for protection work. We did not allow the men to sit around in the lookouts, but we used them in building trails. We got some 58 miles of trail built and 178 miles of old trail opened up by these men.

Mr. PETTIS. Mr. Peters, do you have any regulation with regard to the maximum salary of the Federal employees?

Mr. PETERS. No; we leave that to the collaborator, with the understanding that the normal wage rate in the region will be paid.

Let us now consider the amendments to last year's agreement,[1] which have been proposed. The first amendment is an entirely new section, No. 5, which reads as follows:

5. This agreement contemplates the employment under ordinary conditions of fire hazard of not to exceed ——— Federal patrolmen, or in case of emergency of not to exceed ——— Federal patrolmen in the discretion of the collaborator, provided that in case of serious emergency the latter number may be increased with the approval of the Forester.

By requiring the number of patrolmen which will be employed at any one time to be specified, this amendment provides for a definite program of Federal expenditure for the State to follow throughout a normal fire season. It is designed to prevent the Federal allotment from being used up within a short period, but rather to insure its distribution throughout the entire danger season. We are endeavoring to secure permanent protection in this work. While we are anxious to help every State meet the emergency of a particular season so far as our funds will permit, we are aiming higher than that; we are aiming at developing and assisting the States to develop a permanent protective system that shall, so far as our side goes, measure up to the needs of that State and the practical conditions on the ground. For that reason we are encouraging the use of our funds, in some cases, for a permanent lookout system, and through the amendment I have just read we are asking the States, so far as the use of our funds is concerned, to outline a permanent basis of protection.

The next amendment is the last sentence of section 7, which reads as follows:

This agreement contemplates an expenditure of State funds of at least ——— dollars ($———): and in the event of such expenditure falling below said amount the Federal expenditure will be decreased proportionately.

The purpose of this amendment is to cause the expenditures of Federal and State funds to be made in the same proportion. The State specifies the amount of its own funds which will be available for expenditure on the cooperative watersheds; if, owing to favorable conditions, this expenditure is not reached, then the Federal allotment will only be expended in the same proportion. The outlay by the

[1] A copy of the agreement as amended is contained in the Appendix, p. 78.

State may include the approximate charges for administration, as well as for preventive measures, such as patrol, lookout work, telephone construction, and trail building, and for fire fighting.

The third and last amendment of importance is the first paragraph of section 13, which reads as follows:

13. This agreement shall become effective on the — day of ————, 191–, and shall continue in force thereafter, subject, nevertheless, to the availability of funds appropriated by Congress by the act of March 1, 1911, for the purposes herein mentioned, and to any amendments which may be made thereof by mutual agreement of the parties; and it is expressly understood that this agreement or any modification hereof may be terminated by either party upon thirty (30) days' written notice to the other.

This clause provides for a continuous agreement which may be amended in any particular at any time. The making of a new agreement each year will thus be obviated, while the calendar year feature of the old form of agreement has been preserved in section 7, line 1. The amount of allotment and any other figures will remain the same from year to year unless the agreement is amended.

We will now pass to the subject of employment of Federal men. We wish in the administration of this law to limit the employment of these men to patrol or lookout duties primarily, and we do not want them to be employed chiefly for the construction of improvements. When in the judgment of the collaborator the danger season has begun, he may employ Federal men for patrol or lookout purposes throughout the entire season if necessary. If at any time during the season lookout or patrol work is not necessary, he may employ the men in the construction of improvements, such as lookout stations, telephone lines, cabins, trails, or other fire-preventive measures. If Federal men are paid for continuous work, they must be employed continuously in order that there may be no criticism by the public that these men are not working steadily. We feel, therefore, that the States in which Federal men are paid continuously should supply the Forest Service, in advance of the fire season, with a definite plan of improvement work, showing as nearly as possible how the men will be employed during the periods when lookout and patrol duty may not be necessary. The statement will only have to be in enough detail to show that the work proposed will be sufficient to keep the men busy during the favorable periods of an average fire season. This requirement will apply primarily to the work of patrolmen; the lookout watchmen, especially those stationed in the rougher regions, will ordinarily be kept busy repairing the lookout property and clearing trails.

I would like to ask the collaborators whether the restriction of employing Federal men primarily for lookout or patrol duty prevents our getting the most out of this law, or should that restriction be modified?

Mr. Cox. I do not think that it interferes seriously at all. In Minnesota we sometimes have long periods when patrol is not necessary or when the lookout watchmen can leave their posts; there is plenty of construction work to be done to which they can be transferred.

Mr. Elliott. It has not interfered with us in Oregon at all. We have not only used them on improvement work during the rainy season, but also during short rainy periods in the extremely dry season.

In case of a drying east wind they were put on patrol again in half a day's time. I keep what I call a supervising warden looking after them and directing their work, and whenever there is the opportunity we put them on trail or telephone work. Again, we also use them in slash burning. This restriction has not been any detriment to us.

Mr. PETERS. Gentlemen, is there any objection to the policy of the Forest Service in requiring that Federal employees be given written instructions concerning their duties? This requirement has been very thoroughly tried out in the two years' administration of the law, and has proved generally effective by giving the men a definite idea of the work they are to do.

Are there any questions as to the authority which has been given the collaborators? We wish it to be clearly understood that they are to have as much authority as possible. We have aimed to give them considerable latitude, and at the same time to hold them accountable for results. We have endeavored to eliminate red tape wherever it has been possible to do so.

Regarding cooperation from private owners, we feel that where private lands are being protected the owners themselves should supply a reasonable amount of active assistance through the hire of patrolmen, the construction of lookouts, or other protective measures.

In the prevention of railroad fires it is felt that Federal funds should not be used for the purpose indefinitely, and that the Federal Government should withdraw from protecting the railroads as soon as it can consistently do so, without decreasing the efficiency of the State's protective work. We do not insist upon this immediately, but we ask the State to secure active cooperation from the railroads as soon as possible. The Forest Service might assist some of the States in getting more action from the railroads themselves, or in securing better railroad legislation, by making it known that the service will not permit the expenditure of Federal money indefinitely on work which the railroads ought to do themselves. That is our only object in this matter. We do not want to prevent the best returns in actual safety for the use of Federal money. If the demands of certain States at present require that it shall be spent in patrolling railroads, we are willing to have it done. Sooner or later the railroads all over the country ought to be doing what some of the more progressive ones are now doing voluntarily, or what some of them are doing in States where there is stronger legislation on this subject. I would like to know if it is going to work out that way.

Mr. COX. I should think that would be a pretty good plan. You will remember last year you sent out some instructions in regard to cooperation by lumber companies. I think there is far more reason for enforcing restrictions on the part of the railroads because, with us, the lumber companies have cut their valuable timber and a great many of them own stumpage only. Since they have no interest in the land, they can hardly be expected to get busy on a large scale patrolling it, but the railroad companies certainly can, because it can be easily proven that it is a profitable proposition for them right from the start.

I was wondering just how far you are willing to go in expending money for the inspection of railroad fire protection. We have used

some of our patrolmen more as inspectors of patrols than as patrolmen, and very often they look after railroad patrolmen.

Mr. PETERS. I believe that to be a thoroughly justifiable use of Federal funds. If the railroad is doing the work and cooperating with you, there is no reason, in my judgment, why our money can not be spent for the inspection of that work.

Mr. FILLEY. In Connecticut it was brought to the attention of the railroads this past fall that Government funds had been used on what should be railroad work, with the idea of showing them what they could do not only to help the State but to save money themselves. As a result the chief engineer of the New York, New Haven & Hartford Railroad has asked me to present a report of the patrol work in the past year, showing what the patrols accomplished, how much the work cost, and my recommendations for similar work on the part of the railroad. I think the railroad company will take it up next year on these grounds. It seems to me we could consult with the Forest Service to advantage on railroad legislation, and also make use of the Forest Service statistics in regard to railroad fires and railroad work in other States. I have just learned of railroad work in other States which I did not know of before, and which, I think, if brought to the attention of the railroads in Connecticut, might be of considerable assistance in securing their cooperation.

Mr. HAWES. I would like to be able to spend money on railroad patrols for a year or so longer, for our railroad officials have not become fully educated, and perhaps are more backward than those of some other States. We persuaded the Central Vermont Railroad to furnish passes for our Federal patrolmen last year so that they could go over the dangerous portions of the road as much as they needed. I hope that other railroads will make similar provision this summer, and that in this way we can gradually educate them to the value of a patrol. The railroads have thus far effectively opposed any legislation looking toward requiring spark arresters and similar devices.

Mr. BESLEY. In Maryland we have a great many railroad lines going through the State, and we have been collecting statistics for some time to convince them that they are responsible for a great many of the fires. I think we have convinced them that they are a great source of danger, for they assured us of their desire to cooperate. A year ago last fall one railroad went to the extent of establishing a patrol along its line, and I think it was well satisfied with the result. Others have instructed their men to put out any fires that occur anywhere near the right of way, regardless of whether they started the fires or not. We told the railroads, after we had collected our statistics, that they were responsible for a great many fires and it was up to them to reduce the danger by having fire lines constructed or by employing a patrol. We also told them that if they did not do this, we would feel it necessary to keep a pretty close watch along their lines with the idea of showing exactly how far they were responsible. We have kept in touch with those whose property has been damaged by railroad fires, calling their attention to the fact that the forest law offered them redress, and encouraging them to use this law to the fullest extent.

The Pennsylvania Railroad has in some parts of the State constructed fire lines; that is to say, they have cleared back from the track quite a distance. They are carrying on that work, I understand, in all places where there is no objection on the part of the landowners to having the débris cleaned up and burned. So I think as far as Maryland is concerned we have the railroads with us, and I do not think that it will be necessary to have any further legislation on that subject.

Mr. PETERS. Is there anything further to be said concerning cooperation with private owners or railroads?

Mr. MOWRY. I would like to know the nature and extent of private cooperative work required.

Mr. PETERS. We do not require it; we only feel justified in encouraging it. It may include the hire of patrolmen, the construction of lookouts and trails, or other effective protective measures. Take your own State—Rhode Island—as an example, where the forests are largely in woodlots. The owner in going the rounds of his property, whether a farm or an estate, is at the same time protecting his woodlot. That is a phase of patrol work by the private owner, unconsciously done to be sure, which we will recognize.

Mr. HOLMES. Would you prefer that the Federal money be used in counties where the sentiment is strongly against forest fires than in counties where the people are indifferent?

Mr. PETERS. By no means. I believe that would be a very short-sighted policy to adopt. We want private owners to cooperate, and we feel that it is up to the collaborators to secure cooperation from them, if possible. But we certainly do not want to enforce the requirement to the extent of decreasing the efficiency of the State's protective work.

Mr. HOLMES. Where there is any question about using the money, would it be preferable to expend it where the owners are anxious to have us do so and are at the same time willing to do their share of protecting their own property, other things being equal?

Mr. PETERS. Yes. You understand that after a State has received a given allotment, the State forester may use his discretion in spending that allotment within the approved watersheds, and this question of the extent of cooperation of private owners will be considered by the Service in making the allotment.

Mr. GREELEY. We have started out with the fundamental idea that the primary purpose of this law is education. We can not expect to stop all the fires in the United States with $200,000, and of course we would not try to do so. What we are trying to do is to demonstrate what can be accomplished, and to assist the various protective agencies. In order to make this campaign effective, we have felt we should do something to insist that all of the people who have interests at stake should come into line. We can not lay down a definite ground as to just what they should do, but we feel that they should do something. As in the case of the railroads, we have made it our policy, in scrutinizing the plans which each collaborator presents to us, to ask him for a statement as to how much private owners are contributing and what they are doing. We feel that possibly in that way we might help the State in bringing private

owners into line. I would like the judgment of the collaborators as to how far we should go.

Mr. WILBER. It seems to me that is a point which ought to be left to the men handling the work, because you will find one owner coming in gladly on all sorts of work of that kind while others will not. I have in mind one big estate of about 40,000 acres in New Jersey on which we have been trying to put a lookout station for two years. The owners do not see it our way at all, and it seems to me if we must tell them that this help will be withdrawn from their area if they do not cooperate we are likely to stir up antagonism in a way that will injure us more than it will do us good. On the other hand, if we can go on as we have been in the past two years, running a patrol there and stopping 10 or 15 fires a month, I think we can educate them to our point of view. In our territory I would rather have the coercive feature left more as a discretionary one than to be compelled to club the owners into cooperation with us or drop work on or near their property.

Mr. GREELEY. In other words, you hold the school of educating them with love rather than with a switch?

Mr. WILBER. I think it is more effective.

Mr. ELLIOTT. There is another side to that. For instance, in Oregon we have one county in which there is a great fire risk and there are no large timber holders—no one who has enough timber to justify him in hiring a regular patrolman—and there are absolutely no hired patrolmen in that county except those whom the State hires with the State and Federal funds. Last spring we had a letter from the Forest Service to the effect that we should help especially the timberland owners who were helping themselves, so I went to the county court of this county and put the proposition up to the county something like this: I will put three Federal patrolmen in your country and also our State man, the supervising warden, and I want you not only to furnish your road supervisors as patrolmen but I want you to give them authority to put out the fires at the county's expense; otherwise, under the restrictions from the Forest Service, I do not feel justified in putting in these three patrolmen. They took up the proposition, and so we had an agreement there that in case they did have fires the county funds would be used to put them out. I think that is a splendid example of cooperation, and that is something which we decided should be encouraged.

Mr. GREELEY. Regardless of what Mr. Wilbur says, I think the switch is sometimes effective. How does that meet with your approval, Mr. Cox?

Mr. COX. I do not believe that anything more is needed than we have. I think both methods must be used. In some cases the more peaceable method seems most effective, in others the club is necessary. That instance cited in Oregon seems to me a mighty good one. In Minnesota the local people have frequently taken up this fire problem in a surprising way, and have gone much further than we supposed was possible. In some sections of the State you could not get them interested in it at all. It seems strange there should be such a difference; some communities have practically taken the burden off of our hands and we can readjust our pay roll force for that reason. It is a matter of education pretty largely, and I think it is up to our

patrolmen to devote a good deal of thought and effort to instilling into the local people the whole idea of the thing. Let them see clearly the object of the work and convince them of its value and I think we will save ourselves a whole lot of work.

The session then adjourned.

PATROL.

The afternoon session of the conference was called to order by A. F. Hawes, State forester of Vermont, acting as chairman, at 1.30 o'clock.

The first subject was "Patrol." W. T. Cox, State forester of Minnesota, was called upon to open the discussion.

GENTLEMEN: It is my purpose to tell you briefly of the situation in Minnesota with regard to fire patrol. After the big fire in 1894, Minnesota passed some legislation looking to the better protection of the woods, and rather an advanced law for that time was enacted. It made township officers fire wardens, and the State had for years practically the same system that has been tried out in many other States. However, the system gradually worked into politics, and there were never any adequate appropriations made for its support. Something further was needed to awaken the people, and it was had in the disastrous Beaudette fire of two years ago. The next legislature enacted a new forest law, which is a very comprehensive one. This law provided for a new State department—the forest service—and in order to get it out of politics as far as possible a forestry board was established, which includes the dean of the agricultural college and the director of the forest school of the State university, two members recommended by the board of regents of the university, two by the Minnesota Forestry Association, and one each by the State Agricultural Society, the State Horticultural Society, and the State game and fish commission. The law further provided that the board should select a State forester, who should be a trained forester and who should select his own assistants in the office and in the field. Thus we were given a free hand to select the men and organize the field work, and as a result succeeded in getting a good force of rangers. Our system has been in operation two years.

There are 28,000,000 acres of forest land in the State, of which 20,000,000 acres are really in need of fire protection, the remainder being included in the hardwood country, where there is no great danger of fire, and in the National Forests and Indian reservations, which are already protected and where State rangers are not needed. These 20,000,000 acres we divided into 20 ranger districts. Under each district ranger there is a force of State patrolmen, and on the Weeks-law cooperative areas an additional force of Federal patrolmen. We look to the rangers to select these men. On the start we held an examination. While we are not under civil service, and did not have authority under the law for holding the examination, it seemed a good plan in order to head off the various recommendations which are made. As a result of this examination, a force of efficient men was obtained.

The Federal cooperative fund has been of great assistance to us. It can be expended on most of the forest areas of the State; there is

only a small territory in the northeast, draining directly into Lake Superior, in which we are prevented from using it.

In addition to the State patrolmen, the law provides for various other kinds of patrol; for instance, the organized towns are authorized to vote a tax, not exceeding 5 mills, for fire protection. Over 60 organized towns have voted this tax and provided patrolmen, who must be approved by our district rangers and given appointments by the State forest service. These men work under the rangers and fit into the organization as if they were State men.

Furthermore, the railroads put on patrolmen as called for. The State service has great power to compel the railroads to put on as many patrolmen as are necessary. We call on the district ranger to let us know how many men there should be along a certain railroad running through his district, where they shall be placed, and how equipped. We then call on the railroad company to comply with our request for these men and to maintain them on duty as long as the ranger deems necessary. As a result the railroads have on duty during the fire seasons in the spring and fall something like 200 men in the northern part of the State.

The lumber companies have also put on patrolmen. As a rule, the companies in Minnesota do not own large areas of valuable timber land. They buy timber stumpage in small lots from settlers and others. Many of the larger holdings are cut—at least the pine has been cut off—and the companies do not feel justified in spending money on a basis of acreage, as is done in the Pacific Northwest. However, all of them have camps, dams, and the like scattered over their holdings, where they maintain watchers throughout the summer. These watchers and a few additional men employed for patrol purposes are given instructions to comply with our rangers' requests as to protecting certain districts; in this way they fit into our organization and relieve us of a great deal of the burden of patrol.

The rural mail carriers, as a result of the arrangement which the Federal Forest Service worked out with the postal authorities,[1] were of considerable assistance in the southern and central part of the State, and also helped the rangers in the northern districts to some extent.

The patrol force, considering that it must be distributed over 20,000,000 acres, is only a skeleton force, and the men must be so placed as to do the most effective work of fire protection. We find that it is more effective to place our men on the border of settlements along routes of travel and where there is really danger of fire than to have them patrol districts where a few people go in the summer time or in the fire season. Thus, while on paper it averages something like 280,000 acres to the man, our men actually patrol about 80,000 to 100,000 acres, and there are large districts in which there are no patrols. With more men we could, of course, get much better results.

It is important that the patrolman know the district sufficiently to go around easily and take advantage of the lay of the country. I believe that an outsider is the right man for the head patrolman, though a local man can very often be employed to look after towers

[1] A copy of the Post Office Department's order concerning the reporting of forest fires by rural mail carriers is contained in the Appendix, p. 79.

and similar improvements. In my opinion the rangers should have wide discretion in selecting and directing their patrolmen. The ranger has a large enough territory from which to pick his men and to switch them around, so that they are not really local men.

The patrolmen have been helped a good deal in certain parts of the State by "rural fire brigades." The rangers have gone into these little communities and have been instrumental in organizing forces of men comparable to the fire brigades in villages—volunteer brigades. A captain is selected in each case and definite plans are made for action in case a fire is discovered or reported. The patrolman is thus relieved to that extent, though, of course, if he were in reach he would have charge of the fire fighting.

Returning to the railroad feature—a very important one with us—in northern Minnesota, as in most timber countries, wherever the railroad penetrates the forest there is a strip on each side extending back from 5 to 15 miles where the country is badly burned up. This is true even where settlement is lacking. At a greater distance than that, as a rule, the conditions are very favorable to forest reproduction. Therefore we feel that it is the duty and responsibility of railroad companies to look after their own fire troubles, and they are finally beginning to come to that point of view themselves. We have had a number of meetings with the chief officers of the companies, and some companies favored the plan of putting an immediate end to the fire problem; others, however, were more dilatory about it, but have gradually come into line. While there is a provision of law which requires the maintenance of railroad patrols, we do not want to use the club any more than we can help. We feel that if we can get them to see the reason for the work and the benefit of it we will get better results. Owing to the way in which the railroad company is organized, it is mighty hard to force anything on it, because the responsibility can be easily shifted.

There are about 30 railroad organizations in the State, of which 8 or 10 are important. There are single companies in the State which have paid out $400,000 a year damages as a result of forest fires, and there is no doubt that they could have prevented that loss absolutely by an expenditure of $10,000 a year. That kind of argument appeals to them, and they are beginning to take hold of it. The general manager of one of the large companies announced at one of our meetings that he had looked into the matter thoroughly and was convinced that his company could have afforded to have covered the entire right of way 8 inches deep with gravel and would have been ahead at the end of two years. There is a suit now pending against the Canadian Northern Railroad for $2,500,000 as a result of fires in 1910; they could do considerable in the way of fire protection for that amount.

We are using patrolmen more and more as inspectors and educators, because, after all, the number of fires that they detect and put out is very small compared with the number that could be extinguished by the average citizen, the settler, or campers going through the country. Therefore the thing for the patrolman to do is to educate the public to the idea that there is a force of men permanetly employed to look after this work, and that it is worth doing. There is a notion in the minds of many people that the young forest is worthless; this should

be overcome. If people think that the young growing pine has no value, they will not make much of an effort to protect it; but if they realize that it represents an asset of from $10 to $20 an acre they will view it in a very different light. Back from the burned areas along the railroads, especially in northern Minnesota, there are numerous young forests—hundreds of thousands of acres of as pretty stands of young white and Norway pine as one would wish to see. Of course, that kind of forest has a value, even if the trees are very small, and as soon as the public appreciates such property we are going to have less trouble with fires.

We have equipped the patrolmen in various ways. In the more settled parts of the State we have in some instances furnished horses. In case the patrolmen furnish their own horses the service pays one-half the cost of maintaining them. In the northeastern section of the State we have supplied canoes, which are the common mode of travel there. We have also furnished launches for some of the lakes and larger streams, and in this way enabled one man to do the work of two or three. A great many cabins, lookout towers, and shelters have been erected. For shelters we frequently get the heavy 20-ounce canvas used in pulp mills. In the matter of lookouts we follow a somewhat different plan from that used in the East. In the Adirondacks the observation station is a place where a man stays. With us most of the lookouts are erected on some hill along a trail or canoe route, and they are climbed merely as the patrolmen come to that part of their beat, or if there is a settler or fisherman living in the vicinity we pay him to climb the tower regularly during the fire season and get word to the patrolman in case of fire.

With regard to the telephone proposition we have gone at this also in a little different way from most of you. As I understand it, in the East you have built telephones mainly to the permanent observation stations, which, of course, is the proper thing there. In our case, where there is no one living at the lookouts, we find it more advisable to build telephone lines into the remote settlements. In the northern part of the State there are settlements scattered 20 and 30 miles apart. Some of them are 30 miles from the nearest wagon roads, necessitating our getting into communication with them by wire, and we have built in one case a telephone line that is nearly 100 miles long. Here again we rely on the cooperation of settlers, lumber companies, and others in the region to help us out. We furnish the wire and supervise the work; the settlers and lumber companies do the work, putting up the poles and getting the line in operation. The patrolmen maintain it.

One-half of the State appropriation, or about $40,000, is set aside for strictly patrol work. So far we have laid a lot of stress on the educational feature, as I do not believe it can be over-emphasized in the beginning of such a work as we have in Minnesota. After the service becomes well organized and the people know more about the nature of the work it will be proper to devote two-thirds or more of our appropriation to patrol.

We hope to have a greater force of patrolmen in the future. The legislature is in session now and we are asking for a larger appropriation, which I think there is fair hope of getting.

C. P. WILBER, State fire warden of New Jersey, was next called on and spoke as follows:

GENTLEMEN: First, I want to outline the situation we have to meet in north Jersey, because that is the only part of the State where we can use Federal funds. The whole territory there is within two or three hours' ride by railroad from the metropolitan district. It is commonly called "New York's playground," and includes all the well-known New Jersey mountain and lake resorts. Furthermore, Jersey City, Newark, Paterson, and the large manufacturing centers, where there are many foreigners—the most careless type—who go into the woods in crowds on Sunday, are nearby. There are also a large number of permanent residents throughout the region.

The whole State is gridironed with one of the best systems of roads in the United States, which draws automobilists from all of the New England States, New York, and Pennsylvania; besides there are some 75,000 automobiles in New Jersey. These people are continually passing through the territory, and it is impossible to watch them. Furthermore, the whole country is criss-crossed by railroads. Most of them are coal-carrying roads that have very heavy hauls and heavy grades, which increase the fire danger. In addition, fully half of the gunning around the New York district is done in north Jersey. Trains will stop nearly anywhere to drop sportsmen off, and there is no adequate way to reach them as they go into the woods.

Thus, we have a territory that must be handled differently from sections where there is a large area of woodland sparsely settled and remote. We must prepare for a large body of people all the time. We also must provide for the class of people who go out from the cities on Sundays and holidays, the greater part of whom we can not keep track of. There seems no way, except through general educational work, to reach them. A great many people who come into the territory are from outside of the State. They have no personal or property interest in the work we are doing, and can not be reached as can our own citizens for either education or penalty.

The only way we have found to cope with the problem is by endeavoring to penalize the people who start the fires. We put particular emphasis on getting the offender. If we can make a man pay a fine for starting a small fire, and the fact gets into the newspapers, it makes an impression on the people who frequent or use the forest. I believe we have done the greatest part of our educational work by making it expensive to start fires.

The State organization in north Jersey consists of a division fire warden as an assistant to the State fire warden and a township warden in each township where there is any appreciable amount of woodland, in addition to enough district wardens to adequately control the area. The aim is to assign a warden to each 5,000 acres of land. This force is composed of local men, who receive a small annual fee of $10 or $20 besides the money paid them for actually fighting fires. It is, therefore, a good deal of a voluntary service. These men, as soon as they hear of a fire, get together enough men to take care of it. They have authority to require assistance. Such work is entirely in their hands, and the results through the local organization in this territory indicate that we can rely upon the system.

In handling the Federal fire patrol work I did not know in the beginning how to go at it, because it seemed almost useless to put patrolmen on a road and have them walk 15 or 20 miles a day, if they could cover that much, and leave perhaps 150 miles of road absolutely without patrol.

Our idea first, in the fall of 1911, was to use a large number of men and cover the whole territory for a short period. We did so for two months with about 40 men, and had very few fires, but since the season was wetter than usual, the effectiveness of this plan was not fairly tried out. In 1912 it was evident that we could not afford such a patrol. Further, it appeared that we were not getting enough value from so large a number of men, outside of the publicity feature, to justify such expenditure. Therefore, during the past summer we used from six to eight men at particularly dangerous points where there had been a large number of fires heretofore, principally along the railroads. They patrolled an area of from 4 to 6 miles each, and together they handled as high as 31 fires a month, stopping them entirely unaided and in only one case allowing a fire to get enough headway to require a call for help. It was purely railroad patrol, and I feel that its continuance is not justified. I think, however, it will help us in getting a grip on the north Jersey roads, some of which claim there is no use in patrol. I have not yet had an opportunity to work up the data these men collected, but I think the greatest value of the work will be in showing the railroads that they are setting enough fires to make it worth their while to watch them.

We are placing particular emphasis on holding the railroads liable for the fires they start and enforcing money penalties. We do not collect a large fine, but require the railroads to pay the costs of extinguishment, a great deal in the same way that Connecticut does. This sum is getting larger each year on the northern roads, and probably in time we will be able to put enough pressure on them to look at the fire problem from a practical standpoint, as Mr. Cox has done in Minnesota.

In the fall of 1912 we determined to continue with the small force, but put them in the woods. Most of them had routes covering about 33 miles of road and trail, and the territory was covered in from one to three days. They were picked largely from the 40 men employed the previous year, and we found that we did not have to inspect them continuously to secure conscientious work. They were seen on an average of once a week from September until the last of November, and we found no case where a man had shirked the work. They were told to watch for fires, and in no case to try to fight large ones. If they saw a fire they were to get the township wardens to it and then go on. Special emphasis was laid on the necessity for arresting offenders against the fire laws and penalizing them. There were, however, no arrests, and in two and one-half months there were but five fires per man reported.

I am pretty thoroughly satisfied that in northern New Jersey a patrol system is too expensive a method of protection. I think in a territory of this kind, so accessible to large centers of population, and where the people go into the woods, the lookout system is probably the only one that will pay in the end.

So far we have not been able to do much lookout work in north Jersey, except where in two places we found local families some

members of which would climb a tower six or eight times a day. One of our greatest difficulties in installing lookouts is that there is no telephone communication over large areas. It is localized in the towns, in the large cities, and along the railroads. Our wardens are scattered through the more remote districts, where the State can not afford to put in and private interest is not sufficient to support such service. However, the building of new lines is being extended through the initiative of the telephone companies themselves at every opportunity, with our interest and assistance. When we get such service I am confident that we can put in a lookout system in the northern part of the State which will cover the territory very satisfactorily, leaving the actual fire fighting and what little patrol is necessary to the local wardens themselves.

F. W. BESLEY, State forester of Maryland. was then called upon, and gave the following talk:

GENTLEMEN: Our problem in Maryland is quite different in many respects from the problems in Minnesota and New Jersey.

Cooperative work under the Weeks law is being conducted in the western half of the State, which includes the Appalachian and Piedmont regions. In the Appalachian region there are a few large holdings of timberland, but for the most part the holdings are relatively small. The Federal patrolmen are employed in this region exclusively. In the Piedmont region the holdings are mostly in wood lots; our work there has been largely in the nature of educating the public in fire prevention.

The fire season in the State is confined to two relatively definite periods—one in the spring, from about April 1 to May 15, and another in the fall, from about September 15 to December 15. This enables us to concentrate our efforts and reduce the cost of protection. In certain sections, especially in the wood-lot section, the spring fires are the most common ones and do the most damage. They result largely from brush burning, incident to clearing land. The larger fires, however, usually occur in the fall, in the mountain section.

Our protective system consists of forest wardens, forest patrolmen, and lookout watchmen. The wardens are commissioned by the governor, upon the recommendation of the State forester, the law limiting us to the appointment of not more than one warden for each 15,000 acres of woodlands in the county. The wardens receive no salary, but are paid for services rendered, half by the State and half by the county. Since under our law there are no restrictions in the appointment of the wardens, except as to number, we have been able to select men who would make the best officers, most of them actuated by a high sense of public duty. The chief difficulty is that they are too far apart, and in order to overcome this we are appointing deputies for each warden, with the view of having the men within 2 or 3 miles of each other.

The patrolmen, all of whom are Federal employees, are regularly commissioned forest wardens, assigned to patrol duty. They are usually farmers who know everybody in the community and who understand the local situation thoroughly. These men are assigned a territory covering from 85,000 to 100,000 acres each, and, as far as possible, they travel along the ridges, where a good view of the sur-

rounding country can be obtained. They are mounted on horses, in which respect our system appears to be different from that of other States. The patrolmen furnishes his horse and receives $3 per diem when actually employed, and his patrol is limited to days when it is dry enough for fires to run in the woods. This usually amounts to from 50 to 60 days during the year. By paying a dollar a day more for a mounted patrolman than for one on foot the efficiency, I believe, is at least doubled. There are roads and trails all through the mountains, so that it is possible for a man on horseback to reach about any point desired. He can also cover a much larger territory, and in case a fire is discovered some distance away he can reach the point quickly and get together a force of men with little delay. Our woodlands are not in large, continuous bodies as in the North, and the country is more thickly settled. We find that one of the greatest accomplishments of our patrol service is in showing the people the importance of fire protection. The patrolman is instructed to confer with the property owners in his district and to warn those who are likely to be careless in the burning of brush and the escape of fire. He also visits the school houses to secure the cooperation of the teachers and children in educating the public of the need of fire prevention. The people of this section have become impressed with the importance of the work, because they see the active interest which the State and the Federal Governments are taking in it.

The lookout watchmen aid very materially in the fire-protection plan. We have a number of lookout stations in the mountains. Each one has a telephone connection with the forest wardens, so that a forest fire is quickly observed and reported to the nearest warden. We have found that under this system the fires have not only been reduced in number, but the average area burned over by each fire is very much less than before the system was inaugurated.

In addition to the regular lookout stations there are a number of good observation points where we employ men living near by to make three observations daily during the dangerous seasons, for which they are paid 50 cents a day. We find that this arrangement works very well and saves the expense of a regular station where we would not be justified in having an all-day lookout.

In regard to cooperation with private owners, we have not been able to secure any from the larger owners of timberland, while we have gotten considerable from the smaller owners of wood lots. Our forest law requires that each owner shall, to the extent of his ability, control fires that may burn on his own land. When a fire occurs it is the duty of the forest warden to go at once to it and see that the owner and the help that he may have on the place are doing what they can to extinguish the fire. If the force at hand, with the help of the warden, is not sufficient, then the warden is authorized to employ additional help at the expense of the State and county, each paying half. It is, therefore, the intent of the law that the State fire-protection work shall be supplementary to private effort. In the case of the large nonresident owner, who frequently has no one available for fire fighting and yet who should be just as responsible for the protection of his own land as the resident owner, we have considerable difficulty in having the spirit of the law strictly observed. As a matter of course, we do not discriminate in our efforts

to protect any forest land, but in justice to all taxpayers we feel that the whole burden of protecting the lands of nonresident owners should not be borne entirely by the State and county. We have concluded that the spirit of the law would be properly carried out if each owner of as much as 500 acres of woodland would agree to have one man on the place available for fire fighting, to be paid by him, and an extra man for each additional 500 acres up to 5,000 acres, and for each 1,000 acres in excess of 5,000. One large company has practically accepted this arrangement, and another is, I believe, willing to carry it out, though unwilling to enter into an agreement with us. Some have refused, and many others are undecided. Public sentiment, however, is being worked up and will, I believe, eventually bring some of the doubtful ones into line.

This, in the main, covers our system. We have but few features not found in other States. Under our conditions, where the woodland is in relatively small areas and where the timber is practically all hardwood and is in consequence liable to surface fires only, there is not the need for so extensive a system as is required in the North. The fact that the dangerous season is restricted to three or four months makes it possible for us to concentrate our efforts in fire protection to a small part of the year.

COOPERATION WITH PRIVATE OWNERS.

E. T. ALLEN, forester of the Western Forestry and Conservation Association, led the discussion of this subject with the following address:

GENTLEMEN: Mr. Peters has suggested that I discuss cooperative private work, rather than the Weeks law, in order to help, perhaps, in your attempts to start private organizations in your own States.

The Western Forestry and Conservation Association is a league of such local associations throughout the five Pacific States. It does not do field fire work itself. The first locals to ally in this way were the four Idaho patrol associations that were also the pioneers in cooperative patrol in the United States. They soon joined with a western Washington association, and, as cooperative patrol spread, we took in Montana, Oregon, and California organizations.

Except in Idaho, where the law places State cooperation upon an acreage basis, the methods and organization principles of all these locals are very similar. They are patrol and fire-fighting systems financed by uniform acre assessments upon their members and cooperating with county, State, and Government to the extent possible under the local conditions of these public agencies. As a rule they have the usual officers, with a standing fire committee and a chief fire warden. In contributing acreage they vary from 50,000 to 3,000,000 acres, and the territory patrolled usually is two to three times the contributing acreage because of scattered holdings. The total patrolled by our 14 active constituents is about 20,000,000 acres, and the total expenditure for all purposes runs from $200,000 to $700,000 a year, according to seasonal hazard. This maintains about 450 regular wardens, a shifting force of temporary men and fire fighters, and yearly increasing trail and telephone systems. It protects approximately 500,000,000,000 feet of timber, about a fifth of

the Nation's entire supply. Aggregate losses have ranged from about one-hundredth of 1 per cent in easy years to perhaps one-fourth of 1 per cent in 1910, the worst year in history. Assessments vary with locality and season, ranging from 1 to 15 cents, with an average of perhaps 3 cents.

In Idaho there is no State forest administration other than that afforded through the land board, but there is a law under which timber owners may organize fire districts and have their warden given police power. The State itself is a timber owner, so it joins the association in each district and pays upon its acreage exactly like the rest. In Washington the association does most of the patrolling, while the State helps pay for fire fighting. In Oregon the State appoints and pays the district wardens nominated by the associations and the latter furnish subordinates. In Idaho and Oregon Weeks-law rangers work directly in these State-private combinations. In Washington, the bond being less, they are under the State only, but are stationed so as to dovetail into a related patrol system. In Montana the cooperation is rather less systematic still. In all four States there is systematic private and State cooperation with the Forest Service, varying in method. California, having no State fire work and only one small private fire association, offers little that would interest you except an increasing tendency to place private lands within National Forests under Federal protection, toward which the owners contribute.

But while these local associations exist primarily for actual field fire work, one of their results, and the object of their alliance almost wholly, is the strengthening of the whole protective movement with such elements as the public legislative bodies and nonprogressive lumbermen. A warden cautioning a setttler or a logger to improve dangerous conditions or prosecuting an offender is immensely stronger with a broad, useful organization back of him than he would be as the employee of one timber owner. An association that can show its own liberal expenditure and practical results has an unquestionable right to suggest legislation and request appropriations for State work.

It was discovery of this power resulting from their independent local strength that suggested the five-State league for still more effective educational work and for a clearing house of technical ideas. At first this was pretty much an interassociation movement, but it soon transpired that the Forest Service and the States had practically equal place in it, so the next step was to make the Western Forestry and Conservation Association a sort of triple alliance of private, State, and Federal protective agencies. So now we represent the combined influence and technical competence of all branches and have corresponding strength in molding legislation and public sentiment, as well as a unique usefulness in helping each other in our own work. Each one of the three gets the active help of the other two whenever it needs it to any good end. Recently the British Columbia people have signified a desire to have us take them in too.

These activities of our five-State alliance take four chief forms. One is the function of a clearing house for ideas and experiments in fire methods, as in handling and feeding men, building telephone lines

and lookouts, burning slashings, improving tools and equipment, etc. Secondly, we engage in an active publicity campaign, using every adaptable device of modern advertising. Thirdly, we afford an expert for framing and pressing forest legislation. Finally, and probably most interesting to you in connection with the Weeks law, is our service as a medium for bringing about cooperation between the several agencies in actual field organization of protective forces.

We were all troubled once by the waste of money and ineffectiveness due to duplicate effort and neglect of neutral territory. State, Forest Service, and associations were all sincere in trying to keep down fire and in building up good organizations, but, likely enough, sending three men along the same trail to go after the same fire and equally neglecting some other fire. Sometimes there was mutual suspicion of each other's competence.

But after we got acquainted, through a common working medium, each found the other had much to contribute, and none had any monopoly of advantage that warranted its standing alone. So now they get together—Forest Service officials, State foresters, and association heads—with maps and lists in hand and say, "How can we divide this territory so as to get the best fire protection for the least money?" Roughly speaking, the Service is chiefly interested inside the National Forests, the associations where private timber interests are paramount, and the State in its grant lands and in regions where water supply or settlers demand protection that no one else will give. But there are overlaps of interest and also regions where none would act if obliged to make a sacrifice to do it. We try to divide these up. The best man is put in charge, whether State, Federal, or private, and the subordinates of each are given the right relations, or the territory is abandoned to one agency, which is in turn relieved elsewhere, or some other mutually satisfactory plan is devised. Advance arrangements are made for fixing responsibility in emergencies and for sharing expenses.

The Weeks law money has been a tremendous help in all this. It has forced better relations where they tended to lag. Some of you may have thought it should not go to States that already have Federal aid through the National Forests. To this we can reply that it is quite as important to double the efficiency of an existing joint expenditure of perhaps $300,000 a year by spending $10,000 more as it is to bring about the expenditure of $10,000 in some State that has hitherto spent nothing. It is the addition of a new element—the Weeks law patrolmen—that has necessitated cooperation on a widespread systematic scale and is knitting all parts of the system into an efficient whole for the public good. In Oregon, for example, it has helped greatly in the organization of many new associations with strong patrols where no patrol existed before. The State forester simply adopted the Carnegie library system of inducement, saying to the timber owners and the country, "If you will put in a system of a certain standard of excellence, I will pay a fair share of the cost from the Weeks law fund; otherwise the money will go to some locality that will."

We of the West also feel that the methods of using Weeks law money should be left fairly flexible. While in some regions lookouts are as valuable as patrolmen, in others, or at certain times, they do

little good. It should be possible to put a man at trail building during a week of rainy weather, for example. We think the Service should lay down principles and ideas to guide the work toward uniform ends, but leave enough discretion with the State to insure meeting conditions. I believe this has been the policy of the Service from the start.

Returning again to association work, it has a peculiar field in publicity work that is hard for you to cover as State officials, especially where you are restricted by State printing rules or by statute fixing what you may publish. The association can do anything it has money for, can get the lowest rates, and is not hampered by red-tape or official dignity. The State can then purchase the material from the association at cost, thus receiving all advantage. Our association issues colored pictorial fire warnings, gummed stickers, various illustrated circulars designed for the general public, and special circulars distributed among school children by teachers.

We also prepare copy for use by other agencies at their own initial expense, such as drills on forest-fire subjects to go in State arbor-day bulletins, arguments and precautions printed in time tables by railroad companies and in directories by telephone companies, forest-fire epigrams on checks used by business houses, and all sorts of similar publicity material printed by our State foresters, constituent associations, and anyone else who will make use of it. By gaining a reputation for having reliable forest information on tap, we find a large field in supplying clubs, public speakers, State commissioners, and the like with material for addresses and reports. You will be surprised by the number of people who will call on you for this if you will furnish it in attractive form, keep confidence, and let them use it as wholly their own. Advertise the other fellow, not yourself, and he will spread the propaganda at his own expense. Our principle is to do ourselves only what we can not get done in this way.

In legislative work you will find the association of immense assistance to you. On the other hand, its help to private owners in this kind of work is one of the best arguments with which to organize associations. The foundation principle of success in forest legislation is to have your measures fair to all interests involved and then to enlist all interests in their passage and execution. It is unfortunate to have a legislative movement pushed singly by either the Federal service, a State forester, the lumberman, or the lay reformer. It will seldom either be an ideal measure or receive the necessary support.

With a clean association of forest owners who do useful things themselves and are entitled to a voice, you get a point of view in framing the bill that safeguards you against any impractical features. Moreover, giving them a part removes the indifference or suspicion they might have even if the bill did not warrant it, and it enlists their interest in getting it through. The knowledge that they will also have a voice after its passage makes them far readier to accept what otherwise might seem like dangerous State regulation. Finally, they can get behind a kind of campaign for its passage that you, as a State official, are debarred from attempting. It is our associations' personal and financial backing of a whirlwind campaign that passes practically all of our progressive forest legislation, yet there is

nothing uncommendable in this from the public's point of view, because the bills are also indorsed by the official forest authorities.

Possibly your forest owners may not see the desirability of cooperative fire protection. Often they don't until they have tried it. Then talk to them of the dangers of foolish compulsory legislation at any time likely to be sprung by impractical reformers, quote any examples of this as handwriting on the wall, and show them that by organization with a useful purpose they will acquire a systematized, workable influence against anything of the kind. There is no better way to get a helpful, sympathetic understanding of their industry; a safeguard in all directions, not forgetting taxes. It brings them friends at court, as it were; the friendship of the State, the Forest Service, the educational institutions, and all the mediums that influence public conduct. Once get them together with arguments like this as well as with talk of fire fighting, and in a little while they get the spirit of the whole forest movement and work with you heartily in everything if you deserve it.

In some States you can not get satisfactory cooperation with private owners in fire work, because the law does not provide for it. This is a good ground for getting their organized help in changing the law. I maintain that every State forest law should contain such encouragement; that instead of contemplating a purely official system, it should induce private owners to get into the game and, in return for consideration of their needs, work with you to get freedom from politics, practical efficient personnel, spirit of mutual confidence, and local and technical familiarity with forest conditions, in a combination that can not exist in an exclusively private, State, or Federal system.

Mr. HAWES. Gentlemen, we are fortunate in securing the time of Mr. George Otis Smith, Director of the United States Geological Survey, for a few moments this afternoon. Mr. Smith is here as a representative of the Kennebec Valley Protective Association, and will speak to us on the work of that association. I take pleasure in introducing Mr. Smith.

Mr. SMITH. Gentlemen, I come here somewhat under false pretenses. I am not an expert on the matter of the forests of Maine. I suppose there are States in the West whose forests I am better acquainted with than I am with those of my own State, where I have the privilege of paying taxes and having my children spend their summers. I was, however, one of the organizers of the Kennebec Valley Protective Association. As it happened, I was in the State at the time that the timberland owners of the Kennebec Valley got together and perfected an organization, the principal purpose of which is to aid the State and Federal Governments in their fire-fighting work. It is essentially a timberland owners' association. The membership is based and the right of voting is based upon acreage ownership. The organization is small, though representative of large ownership.

I simply desire to call attention to the fact that the directors are given large powers in the matter of authorizing very informally, but very effectively, an assessment which may amount to 5 mills per acre. That is simply an emergency measure, the purpose of the association being more to stand in the background and assist the

State and the United States officials in their work. When there is need for a reserve being called into the field this association stands ready, and its five directors have the power to vote very expeditiously money for fire fighting in addition to that which is available on the part of the State. We trust that that power of the directors may not have to be exercised, but it is quick money that they can vote, because these men are leaders in the industrial activities of the State, and they do not have to go to the bank to get money; their word is enough for the men who will go on the fighting line.

Maine seems to me to be more comparable in these matters to one of the Western States than any other of the Eastern States for the reason that it is sparsely settled. We have about 30,000 square miles in Maine, and the greater part of it is really wooded, even in the southwestern portions of the State.

The northern half of the State is densely wooded and practically unpopulated. Piscataquis County, which lies in the central portion of the State, has a population of a little over 5 per square mile, whereas our country as a whole has 31 per square mile. So the conditions are altogether different from what they are in the old State of Massachusetts. I believe, however, that the lookout service is quite similar. While I can not speak authoritatively regarding the present method of establishing these lookouts, I remember when the first ones were established, which happened to be in the Kennebec Valley. The procedure was for the landowners of certain areas to get together and meet the expenses of erecting shelter and putting in the telephone line. Then the State would step forward and take on the upkeep of the station.

There are now 28 lookout stations, all located in the Maine forestry district, which includes the wild lands of the State. Emergency tool boxes are distributed over this district at advantageous points. They are similar, I suppose, to what you have in the other States, the equipment being from 1 to 2 dozen tools, or in some cases 5 or 10 dozen.

I believe we can not lean too heavily upon the work of the Federal and State Governments. While their work must be carried on in a way adapted to normal conditions, in time of war the reserves must be called out, and this association is like the organized militia of the State—ready to go to the assistance of the standing Army.

E. C. HIRST, State forester of New Hampshire, followed Mr. Smith.

GENTLEMEN: I will take this subject up under two heads, cooperation with (1) large owners and (2) small owners.

Cooperation with the large owners in New Hampshire is confined almost entirely to an association formed two years ago. This association was the first one of its kind in the East. About three years ago the State forestry commission called a meeting of the large timberland owners of the White Mountain region to discuss fire protection. Mr. Cox, who was then in the Forest Service, came up and spoke to us on how the Government cooperates with fire protective associations in the West. At that time most of the owners did not think it necessary to organize for fire protection. Most of them were willing to do something, but felt that the best way was for each owner to turn over the amount of money he was willing to expend each year directly to the State forester and let him use the funds, together with the State appropriation, to the best advantage.

At that meeting the timberland owners present subscribed about $5,000, and gave it to the State forester for the building of mountain lookout stations. During the summer of 1910 nine stations were built and operated. At the end of the fire season the owners who had contributed held another meeting and the State forester reported how their funds had been used. It was then decided that the owners could best cooperate with the State through an organized association, and the New Hampshire Timberland Owners Association was later formed and incorporated. Some of those who went into it did not think it would be permanent. However, during the first year of field work the association demonstrated its usefulness pretty clearly, and I do not believe there are any members now who could be driven out of it.

I have here a map which shows how our fire-protective system operates. The black lines indicate the fire districts; there are four of them, each supervised by a district chief employed by the State. The Weeks law cooperative area is within the three northern districts, as also is most of the land of the association owners. In 1911 New Hampshire experienced the most dangerous fire year on record. In the three northern districts, where most of the wild lands are located, there was very little fire damage, due to the cooperative system which had been worked out between the Government, the State, the towns, and the timberland owners. In the southern district, however, which is largely a wood-lot country, and in which we have heretofore not expected serious fires, there was more damage than in the other three districts together. This at once shows the benefits of cooperation and indicates that it must be extended into the southern wood-lot region.

The work of the timberland owners' association is divided into patrol, lookouts, and education. Early in the spring, as soon as we find out just what money the State can spend on fire protection, and as soon as our agreement is completed with the Federal Government, the forester for the association, Mr. Billard, and I get together for a conference. I prepare a State and Federal budget for the fire season, and he plans the association work to supplement and strengthen the State and Federal work. He tries to spend the association's money, as nearly as he can, in the regions from which he derives the revenue. The association members assess themselves 1 cent an acre a year, which may be increased in case of emergency, and he tries to give each locality adequate or proportional protection. By putting a little money in the form of patrol, or trail building, or something of that kind, into the different localities from which he gets revenue, he can secure more members. The Federal Government has purchased 72,000 acres in the White Mountains proper, which was formerly association land, but Mr. Billard has been able to get enough additional members to offset that purchase, so that there will be just as much land in the association next year as there was before.

The greatest value of the association's patrol service is that it is so very elastic. In 1911 our agreement with the Forest Service for the Weeks law patrolmen did not go into effect until June 2, but we had had fires in the mountain region as early as April 30. The association stepped in and hired about 75 patrolmen, doubling the force on Sundays and holidays. This filled in a gap when we

would otherwise have had inadequate protection. Throughout the summer Mr. Billard aims to keep on a small number of permanent patrolmen, but can expand the field force quickly if necessary. He usually takes this up through the town fire warden, visiting each one in the spring and making the arrangements. The warden is given the first chance at the patrol job, and this keeps him interested in the association's work. If he does not want to do the patrolling himself, he usually hires somebody near by and keeps a watch on him.

The association has also been able to extend the State work a great deal. The lookout stations it first built have been taken over by the State through a special appropriation made for the purpose. It would have been very difficult to get a bill through the legislature to establish lookout stations without first demonstrating their usefulness, and the association enabled us to do this. Last year it built additional stations, which we hope to take over at this coming session of the legislature, and continue that policy until the whole State is covered with as many lookout stations as are needed.

In addition to building the stations, the association built a number of telephone lines into dangerous localities and along patrol routes. In some cases it has been possible to repair and use old lines abandoned by lumber companies, which were formerly used along driving-streams or for connecting camps. In this way they have built new or reconstructed about 100 miles of telephone line.

The association also does a great deal of educational work. Mr. Billard plans to be in Concord all the time the legislature is in session to appear before committees and explain legislative measures to members individually.

I am not able to give so favorable a report from New Hampshire on cooperation with the small owners. Since we get such good results in the mountain region, where we secure effective cooperation, it is clear that in the rest of the State we have got to make the State or the local communities or the private owners do more. I do not see how we are going to get these small wood-lot owners together in an organization.

It is possible we may be able to work it out on a town basis. We have a pretty good set of fire wardens, and it has taken quite a while to get them. Most of them are willing to do a great deal in the way of local organization. We are following up the warden appointments by sending our district chiefs around to each town and having them get in touch with woodland owners. The town warden has furnished us with lists of all the persons in each town who own any woodland to speak of, and the district chief, as he has time, makes it his business to visit them. If he finds a place on a hill where some one is living who has a telephone and can look over considerable country, he goes there and makes arrangements for the owner to report fires to the warden, and leaves a list of town fire wardens and deputies in the vicinity, with their telephone numbers. There may not be a great many fires reported from such places, but it spreads the information of fire protection throughout the town. Then if there is anybody who has been employed and owns tools that can be used for fire fighting, the district chief makes an arrangement with him to furnish these men and tools in case of fire. I am inclined to believe that it is along that line that we will have to work for cooperation with the owners in the wood-lot regions. Perhaps

by organizing local forestry societies, like the Society for the Protection of New Hampshire Forests is doing, we may develop volunteer forest-fire companies in the rural towns. In that way I think we can build up some kind of an effective cooperation with the small owners, but I rather doubt whether we can go as far as getting them to pay any assessment on their timberland for fire protection.

DISCUSSION.

Mr. PETERS. I would like Mr. Hirst to explain why we made Mr. Billard, the forester of the New Hampshire Protective Association, a collaborator in the Forest Service.

Mr. HIRST. I requested his appointment because he is in the field nearly all the time looking after his own men. In 1911 we found that the Federal men to whom he would give suggestions did not really know whether they were under him or not. Now, however, that he is appointed a collaborator in the Forest Service, we place in the fire budget to each district chief a notice that Mr. Billard is in charge of field work in the absence of the State forester. It gives one more man, who is in the field considerably, authority over the patrolmen.

Mr. HAWES. Does the Forest Service take the stand that in any case where a cooperative organization is formed the forester in charge will be appointed a collaborator?

Mr. PETERS. Yes; to a reasonable extent, provided his appointment would further the effectiveness of the work. For example, in Idaho there are five collaborators, including the commissioner of the State land office and the chief fire warden of each of four timber protective associations. Under the law the State as a timberland owner is authorized to cooperate with other owners, and it does this through these four associations.

Mr. COX. I would like to ask Mr. Hirst if the association members pay on a basis of total acreage or of only uncut timberland?

Mr. HIRST. Total acreage, including cut-over land.

Mr. HAWES. I will ask Mr. Cox to speak of his experience in securing cooperation from private owners in Minnesota.

Mr. COX. We have not had so very much cooperation with the lumber companies. As I have already said, they have their camp watchers, and some companies have put on a number of patrolmen in addition. The iron companies which have large holdings in northeastern Minnesota, especially the steel trust, have a regular forest service of their own. They cooperate with us very fully, putting their men under our district rangers to a certain extent, but they, too, have what might be called district rangers. We feel that the lumber companies are doing almost enough in looking after the disposal of their slash, and that it is up to the State to look after the patrol work. In meeting the slash requirements, which are very stringent, the companies are paying the equivalent of $300,000 a year for fire protection, so we feel that they should not be called upon to contribute very heavily in the matter of patrol.

Mr. HAWES. Mr. Wilber, what have you to say on this subject?

Mr. WILBER. We have not been able to secure any private cooperation to speak of in North Jersey. The only people we can turn to are those owning large estates, many of whom have their own pro-

tective systems, which they consider better than ours. I have been trying for 18 months to get some sort of cooperation on one property in installing a lookout on a high mountain. It will entail on the part of the owners the expense of building probably half a mile of telephone line, but they can not see the advantage of it. These owners are, for the most part, satisfied with things as they are. On the wood-lot proposition I agree with Mr. Hirst, that it is exceedingly difficult to bring these people together.

Mr. ALLEN. Where you have had this difficulty in any association, may I ask whether the small man has had an equal vote? How is that in New Hampshire?

Mr. HIRST. In the New Hampshire association every man has an equal vote. That policy was adopted in order to bring the small owner in.

Mr. ALLEN. It helps to allow the small man equal vote; that is, to make membership privileges uniform without regard to acreage. He then takes more interest and is less apt to fear he will not be looked after as well as large contributors. All our associations do this.

Mr. WILBER. I would like to ask Mr. Allen whether in organizing an association he thinks it should be wholly private, with a private individual to handle it, or could the State forester handle it?

Mr. ALLEN. It would depend considerably upon existing sentiment and upon the confidence in the State office of those who would be involved. Generally speaking, however, I should prefer to see the timber people feel that they were doing the work, so as to insure their own interest, but have the association cooperate with the State very closely. It would not be so strong with the public if it didn't, nor would you feel so safe with it. On the other hand, in getting efficiency in the woods through good men well handled a private organization has an advantage over the State forester. It is closer to the job and free from politics. It can insist on getting maximum results from every dollar spent. And why should the State forester have to spend valuable time supervising and inspecting men doing things which the local owners have just as much interest in and will look after as well or better? Is it not better for him to be relieved, where possible, and have more opportunity to work where he can not get such help? I think every element, public and private, has a duty and responsibility in forest preservation and that the task should be divided fairly and to insure that each contributes its special efficency.

Mr. HAWES. I would like Mr. Allen to say something to us about the development of specialists by fire associations.

Mr. ALLEN. This has been one of our great opportunities. Being free from the miscellaneous administrative duties that take so much of most State and Federal forest officers' time, we can detail men to particular lines exclusively and make them highly proficient.

For example, one of our great problems is the disposal of slash. In red-fir lumbering there is no selection cutting, leaving a thinned stand to protect, but we cut clean and burn the slashing in order to reduce risk and facilitate reproduction. This is required by law. While approving of the principle, few lumbermen really like to touch the match to slash, especially when it is dry enough to burn. To do it both safely and effectively requires more experience than he gets in his own operations. So the associations develop expert slash burners,

who work at this exclusively during portions of the year, burning many thousands of acres under varying conditions, and are able to decide when it is safe and what precautions are necessary. They relieve the individual operator of the responsibility, and it is such assurance that the work will be regulated by experts that makes lumbermen accept what might otherwise be dangerous legislation.

It is much the same with spark-arrester laws. Operators are glad to have them when they feel that enforcement will be largely in the hands of association engine inspectors who know the subject in a practical way.

There are other things a strong association seems to be able to accomplish better than State or Government. Patrol and the use of oil fuel by railroads would not be as far along in the West were it not that the associations include big shippers and men of wide business influence who can get the ear of railroad officials. I do not think the Forest Service could have had the Army ordered into fire work in 1910, but when our alliance of associations, themselves spending $700,000 that year, telegraphed the President, departmental prestige or jealously had no bearing.

So in trying to form private associations in your States, show the timber owner that this is the way to get a voice in all things that affect him, and thus to safeguard himself against compulsory legislation that might be dangerous if enforced wholly by impractical men. He will be a tremendous help in getting things you can not get alone as State officials.

RAILROAD COOPERATION.

W. O. FILLEY, State forester of Connecticut, opened the discussion of this subject, as follows:

GENTLEMEN: Connecticut is primarily a manufacturing State, but the agricultural interests run a pretty close second. Less than one-half of the State's area is suitable for cultivation, and nearly all the remainder is beter adapted to the raising of trees than any other crop. In handling the forest land the largest factor is the fire problem, and in studying this problem during the last eight years we have found that the railroads cause the largest number of fires. During the last four years the railroads have been responsible for about one-third of all the forest fires in the State. So we have tried to get the railroads to cooperate voluntarily by means of patrol. In 1908 Mr. Hawes, the State forester, made an arrangement with one of the railroad companies providing for a patrol along a certain section of track for a period of three weeks or a month. Although the practical value of the patrol was clearly demonstrated to the railroad, we could not persuade the company to take the matter up voluntarily. A little later State Forester Spring prepared a bill for the legislature which would have made patrol compulsory on the part of the railroads, upon instruction from the State forester. The railroads were opposed to any such measure, and they offered a substitute making themselves liable for the cost of fighting fires which they started. This seemed worth while accepting, and for the time being we dropped the idea of compulsory patrol. The measure was enacted into law in the summer of 1911. If it had been in effect in the spring thousands of dollars would have been saved, which were paid by the

State and towns in fighting fires. That was the most serious forest fire year we have ever had.

The only other law in the State relating to forest-fire work by the railroads is one which makes them liable for damages caused by fires they start. Although we have only about 1,500,000 acres of forest land, about 65,000 acres of that area were burned over in 1911, almost all of it in the spring. Thirty-three per cent of the fires and nearly 33 per cent of the damage were caused by railroads.

Those of you who are familiar with Connecticut know that the valley through the center of the State is largely agricultural land, and the forest land is in the shape of small wood lots. The conditions are similar to those of many portions of New Jersey, Maryland, and Massachusetts. The hilly areas in the eastern and western parts of the State are pretty thoroughly cut up with deep valleys, and the railroads run through them or cut through the hills. The hills are usually well covered with forest growth; in fact, there are extensive tracts of unbroken woodland, and the railroad fires occur almost entirely in the hill sections. Therefore we can reduce the railroad problem to a very small area if we can get the railroads to see that those sections must be attended to.

Last year we used the Weeks law funds for railroad patrol, because we felt that its use for this purpose would give the most satisfactory results. We wanted information and data which we could present to the railroads in regard to patrols. Although in 1912 there was a comparatively wet spring, and we had only 250 fires as against over 800 in the spring of 1911, yet 43 per cent of the fires in 1912 were due to the railroads as against 33 per cent in 1911. I think next year we shall be able to get from the railroads the cooperation for which we have been working so long. I do not feel we need any law compelling patrol, for I think we can get the help of the railroads in this matter without compulsion. If we can get them to patrol voluntarily, it will produce a better cooperative spirit between the railroads and ourselves. They already cooperate with us to the extent that when we report the right of way in bad condition they usually clear it pretty well; and they issue general instructions to their section foremen to cooperate with our fire wardens in every way possible. The section hands in some parts of the State do very well, while in other parts their cooperation is rather perfunctory, and for the least excuse they shirk it. It depends entirely on the foreman. So far as the higher officials are concerned, the instructions are clear.

Conditions as regards the motive power of the railroads are going to change in Connecticut greatly during the next few years. The New York & New Haven section is being electrified now, and the Hartford section will be electrified later on. Therefore it is only a matter of a few years when fire danger from railroads in the State will be greatly reduced. Yet it may be advisable for us in Connecticut to have a law compelling inspection of the locomotives, because it seems to me patrol work is not getting to the bottom of the trouble. We ought to go further back than that and eliminate the cause of fires. Our patrols have reported defective locomotives, and we have notified the motive department of the railroad of their numbers. In some cases the locomotives have been taken off, but when returned to

service they seem to set just as many fires as before. We have no power to compel them to repair locomotives at present.

I want to say that Massachusetts, being next door and having more stringent laws than Connecticut, helps us quite a little. The attitude of the railroad companies has changed considerably because of the fact that they are required to take precautions in Massachusetts.

DISCUSSION.

Mr. ALLEN. You have a spark-arrester clause?

Mr. FILLEY. No; but the locomotives are equipped with spark arresters, and these are what we record as being out of order.

Mr. HUTCHINS. I think you will find the worst trouble comes from the ash pans. The New York, New Haven & Hartford's are in very poor shape.

Mr. FILLEY. I know that much trouble comes from the ash pan. However, fires often occur in cuts where the sparks are thrown up on the bank, and in such cases the spark arrester must be to blame.

Mr. GASKILL. The question I want to ask is directly the contrary to that which has just been propounded. Why should the State take up the question of spark arresters or ash pans? In my experience, which has not been confined to New Jersey entirely, it has been demonstrated pretty conclusively that such a provision of law affords a refuge behind which the railroad companies can secure immunity against claims for damages. Precedents and decisions in New Jersey, at least, are almost all to the effect that compliance with any such requirement absolves the company from consequential damages.

Now, we absolutely weaken our position, in my opinion, by imposing any such requirement upon the companies. I can go one step further, in personal experience, if you like. In discussing the origin of a large number of fires along one of our railroads with a chief engineer, we went into the question of the efficiency of spark arresters—we all know what that is, more or less—and he stated frankly and clearly that they do not do and can not do what is claimed for them. Finally I said, "Will your company agree to the repeal of that clause in our railroad law?" He said, "No;" they preferred to let it stand.

Mr. PETTIS. I can hardly agree with Mr. Gaskill. I will agree to this extent: That I believe the railroads are glad to have inspection, provided it is done by competent men, for the reason that it relieves them of that much expense. On the other hand, when it comes to a question of proof that they caused a fire, I think we are in a far better position. In other words, if our inspections are thorough enough, we know the condition the engines are in. At the present time we have a case as the result of a fire by the Erie Railroad Co. The inspection of three engines, one of which caused the fires, were all made about three or four days before, and all of the engines were found to be in bad shape. I believe if this inspection had not been made we would have had trouble in trying to make a jury believe the fires were caused by defective spark arresters.

Mr. GASKILL. May I contribute one piece of information which I have found is news to a number of men? It is to the effect that the harder the coal the more readily are fire-bearing sparks likely

to be discharged through a standard spark arrester. It is easy to understand why. The softer coals, the bituminous and semibituminous, coke quickly and exhaust themselves rapidly. They frequently expand after going through the screen, and when thrown up into the air they flare up, but strike the ground practically dead. On the contrary, take anthracite as the extreme of the hard coals, and you will find that small sparks can be discharged through the screen of an ordinary arrester, and yet those small sparks will reach the ground in a condition capable of setting fires. In other words, I have found that fires in many cases come from the small brands, not from the big ones.

F. W. RANE, State forester of Massachusetts, was then called upon to tell how his department is solving the railroad fire problem.

GENTLEMEN: When I went to Massachusetts six years ago we did not have a single statute on our books with regard to the regulation of spark arresters on railroad engines or anything else relative to fires set by railroads. I think that in all probability more real gain has been made in the past two years than in any previous time. This has been due to the fact that we have a specialist in Massachusetts, in Mr. Hutchins, who had had a lot of experience in New York with railroads before he came to us.

I secured a law whereby we compelled the railroads to have spark arresters on engines, but the enforcement of the law was put into the hands of the railroad commission, because we thought it would be easy for them to enforce it. When Mr. Hutchins was employed and we began to look into matters more thoroughly, it was found that the spark arresters on the engines were in very fair condition, and that the cause of fires was largely a question of defective ash pans, a thing the railroad officials and their engineers apparently did not know much about.

It has been a process of education with me, and I am sure it has been with the railroads. Recently each railroad has placed a man in charge of this special work. The master mechanic is constantly going over his engines in the different companies. It is not a question of Massachusetts alone. The New York, New Haven & Hartford runs through Connecticut and the Boston & Maine is in every other New England State. It is not a question of just one State looking the matter up, but of all pulling together. Last year we had a splendid record so far as railroad fires were concerned. About a year ago the Boston & Maine Railroad appointed Mr. E. A. Ryder, a man experienced in the business, to have charge of the work. Mr. Ryder has gone into the matter of forest-fire protection and is an expert on that question to-day. The report that he sends in to us in regard to fires in Massachusetts is a masterpiece. Every single fire that has occurred, big or little, has been reported by the railroad. He goes, therefore, even beyond the reports that come principally from our forest wardens in the various sections. This shows that if the railroads want to cooperate they can, and I think it has been demonstrated sufficiently, and will be through Mr. Ryder's report, that they can not afford to do otherwise than to have a man of this type in their employ.

Our experience last year was very satisfactory until within six weeks ago, when all at once fires began to break out in one district.

and we seemed to be returning to 1911 conditions, so Mr. Hutchins concentrated his men there. We have three automobiles now, so that our men can go from place to place quickly. They found upon investigation that a large percentage of these fires were caused by defective ash pans and front ends. I took the matter up with the railroad commission, and found that they did not feel that they had sufficient authority to give us permission to examine the engines, so we drew up a tentative bill. We said we were going to propose to the legislature that we be given more authority, but I thought it would not be necessary to go to the legislature for an act of that kind if the railroads wanted to take hold and cooperate. The railroad commission thereupon called a meeting about a month ago of all the railroads that come into Boston, and we got together and had the most satisfactory meeting we have ever had. The very fact that Mr. Hutchins knows what he is talking about, and knew something about the engines, and the fact also that the railroad commission put a man on the work as their deputy—he is an ex-engineer and also has gone to the bottom of things and can give them information—lead toward the point we are aiming for. The railroad people who came to the conference told us how many engines they had remodeled last summer, how many they have to remodel, and how many weeks it is going to take them to get the rest of them remodeled. They have a feeling that they are going to handle the problem. At the last meeing the State fire warden and his four deputies were allowed the privilege of inspecting all locomotives on the different roads. The railroad officials preferred to grant this request rather than to have us ask for extra legislation covering the inspection of locomotives. Therefore, I think the thing for us to do is to cooperate with the railroads and not ask too much legislation, and in that way I believe we can bring the present difficult matter under control.

Mr. PETERS followed Mr. Rane's address with the reading of a paper from E. M. Griffith, State forester of Wisconsin, who was unable to be present.

GENTLEMEN: Our legislature of 1911 gave Wisconsin one of the strongest and most practical laws in the country for reducing the number of forest fires set by railway locomotives, donkey, traction, and portable engines. The following provisions of the law are worthy of special note:

(1) Between March 1 and December 1 all logging locomotives, donkey, traction, or portable engines which are operated in, through, or near forest, brush, or grass land and which do not burn oil as fuel must be equipped with screens or wire netting on top of the smokestack so constructed as to give the most practicable protection against the escape of sparks and cinders. "The term logging locomotive, as used in this act, shall be construed to mean any locomotive operated on a railroad, branch line, or division the chief or main business of which is the transportation of logs, lumber, or other forest products." The great value of this provision of the law will be at once apparent to any forester, as it compels every locomotive which is operated through the forests to be equipped with the oldest, simplest, and yet by far the most effective device for preventing the escape of sparks or cinders, namely, a screen or hood over the smokestack. Locomo-

tives operated on main through lines which make long runs could not be equipped in this way, for with the smokestack covered with a hood the front end of the engine would clog up with cinders and then, of course, the engine could not steam or pull its load. Therefore the law provides that "all locomotives operated on any railroad other than a logging railroad shall be equipped with the most practicable spark arresters, so constructed as to give the greatest possible protection against the escape of sparks and cinders from the smokestacks thereof, and each such engine shall be provided with the most practicable device to prevent the escape of coals from ash pans and fire boxes and such devices between March 1 and December 1 shall at all times be maintained in good repair."

(2) The law provides that the superintendent of motive power or equivalent officer on each railroad shall designate an employee of such railroad at each division point and roundhouse who shall examine each locomotive each time it leaves the division point or roundhouse between March 1 and December 1, and such employee shall be held responsible for the proper carrying out of the provisions of this section, but without relieving the company from its responsibility thereunder. This provision of the law has proved very effective in keeping the locomotives in proper condition, and also in bringing about real cooperation between the State and the railroads.

(3) It will be noted that the law provides that screens or hoods on the smokestacks must give the "most practicable protection" and that spark arresters must be constructed so as to give the "greatest possible protection." The question naturally arises as to who shall decide as to the most practicable device. This is provided for in the following section, which is the strongest part of the entire law:

Any locomotive inspector designated by the State board of forestry shall have the power to reject from service immediately any locomotive, donkey, traction, or portable engine which, in the opinion of the said inspector, is deficient in adequate design, construction, or maintenance of the fire-protective devices designated in sections 1 and 2 of this section, and any such locomotive, donkey, traction, or portable engine so rejected from service shall not be returned to service until such defects have been remedied to the satisfaction of the State board of forestry. In case of disagreement between said inspector and the owner of the locomotive, donkey, traction, or portable engine so rejected from service as to the efficiency or proper maintenance of said protective devices then the owner of said locomotive, donkey, traction, or portable engine may appeal to the railroad commission of Wisconsin for a decision of said matter, but pending such decision the said locomotive, donkey, traction, or portable engine shall not be returned to service.

Particular attention is called to the fact that any defective engine can be ordered out of service and that it can not be returned to service until the defects have been fully remedied. This provision of the law is extremely important and is far more effective than the usual fines, for any railroad that was inclined to disregard the law would be quickly brought to its senses by having its locomotives ordered out of service.

(4) Minor though important provisions of the law are:

(*a*) Railroads must provide patrols for duty along their tracks in dangerously dry weather, and if any railroad fails to provide such patrols after due notice, the State board of forestry may employ patrols and charge the cost to the railroad.

(*b*) Every railroad must at least once every year cut and burn, or remove from its right of way all grass, weeds, brush, logs, and refuse material.

(*c*) No railroad shall permit its employees to deposit fire, live coals, or ashes upon its tracks outside of the yard limits, unless they be immediately extinguished.

(*d*) Engineers, conductors, or trainmen who discover fires along the right of way, or on lands adjacent to the railroad, shall report the same to the agent at the nearest telegraph station.

The main causes of railroad fires are sparks which escape from the smokestacks, and live coals which are dropped by the ash pans. The Chicago & North Western Railway has been cooperating with the State for the last three years in an endeavor to perfect a spark arrester which would prove entirely satisfactory in preventing the escape of sparks, and though great progress has been made, complete success has not been secured as yet. It is a comparatively simple matter to get an arrester that will stop a locomotive from throwing sparks, but very difficult to find one that will also allow the engine to steam freely and pull its load.

The State board of forestry has a locomotive inspector who devotes his entire time, from March 1 to December 1, to inspecting locomotives in the forest regions of the State, and he is constantly working with the railroad officials to perfect improved devices. A brief summary of his report for 1912 follows:

SPARK ARRESTERS.

The Chicago & North Western Railway now uses the Slater box front-end on nearly all of its engines operating in the forest reserve regions. This front-end is a big improvement over the old style known as the master mechanic front-end. Fifteen night runs were made on engines equipped with the box front-end, and several on engines equipped with the old style front-end. Less sparks are thrown from the stack when the former is used, and it is estimated that less than 5 per cent of the sparks are alive when they strike the ground. The box front-end is in nearly every case a self-cleaner, while the old style is not, but the engine crews state that it is harder to steam with than the old style and that it uses considerably more fuel.

The Great Northern Railway has experimented during 1912 with a new spark arrester, known as the cannon or conical front-end. Four night runs were made on engines equipped with this arrester, and one night was also spent in the tower at Saunders, Wis., watching 25 engines which passed. Very few sparks were thrown from the stack, and only occasionally would one reach the ground alive. The engine crews do not appear to have any fault to find with this arrester.

A number of other spark arresters are being tested, and the necessity for finding the best possible device is so great that the investigation will be continued along all possible lines.

HOODS AND SCREENS.

The Chicago, Milwaukee & St. Paul Railway, during 1912, has used a very satisfactory hood on all its engines operated through forest lands. The hood is fastened to the top of the smokestack with a hinge

at the back. At first engineers and firemen were inclined to tip the hood back when they thought there was not much danger from forest fires, but close supervision and the fact that one or two men were laid off by the railroad for doing this, has largely put a stop to the practice. This is considered to be the best hood in use, the only objection to it being that the cinders are apt to fly back into the engine cab, but a device was perfected last August which overcomes this trouble to a certain extent.

Some of the smaller railroads and a number of lumber companies use the old diamond stack, with a large top and cone well down in the stack. This type of stack has been found very expensive to keep in good repair, and the front ends sometimes choke up, since they collect a lot of cinders. It would appear that an entirely satisfactory hood has not been worked out as yet, but the type of hood used by the Chicago, Milwaukee & St. Paul Railway is fairly satisfactory.

ASH PANS (HOPPER BOTTOMS).

There are many of this type now in use, but frequently a hopper ash pan supposed to be in perfect condition is found upon close examination to still allow room for some live coals to fall through. It seems absolutely impossible to make a sliding or tilting door which will not warp or crack and which will always come up tight.

The Chicago, Milwaukee & St. Paul engines are equipped with one of the very best types of hopper ash pans now in use. They are an improved Chicago, Burlington & Quincy Railway ash pan, and are considered to be a great improvement over the original. The doors open at the ends and are equipped with an automatic latch, which is easily opened and yet can not be jarred open. About 40 of these ash pans were inspected during the season and only one defective door was found.

The hopper ash pans, which were in use by the Omaha Railway early in the season of 1912, were found to be a very inadequate type and in bad condition. The many forest fires that occurred along its lines in 1908 and 1910 were undoubtedly very largely caused by these ash pans. In the latter part of July, 1912, this road began to equip its engines with a new ash pan, known as the swipe pan, which has a sprinkler blowout. This type gives promise of proving very satisfactory.

The inspection of locomotives in 1912 is summarized as follows:

	Number.	Per cent.
Locomotives examined	651	100
In good condition	327	50
In fair condition	145	22
In bad condition	126	19
In shop for repairs	41	7
Ordered out of service	12	2

DISCUSSION.

Mr. ELLIOTT. In regard to the inspection of engines, I do not think we ought to require the State to do that at all, but the railroads themselves. Our law says that all engines must be equipped with ade-

quate spark arresters; if an engine sets fire along the road, it is prima facie evidence that the spark arrester is not satisfactory, and the use of the engine can be enjoined. We had a little trouble in 1911 with a company that I had worked for for a number of years. We kept getting reports that certain engines were scattering fire. I wrote the superintendent and got a very nice reply, stating that he had taken the matter up with the master mechanic, who reported that all the engines were inspected every time they came in and that the best spark arresters the road could get were being used. I simply sent back a copy of the law, calling his attention to the fact that there were still reports coming from our wardens and patrolmen along the railroad that certain engines were setting the fires. I told him that if the engines continued to set fire, I would take steps to have them shut down. Immediately we got action. The roadmaster was right out along the road watching the engines and finding out just what the causes were. We found that while some of the engines were scattering fire from sparks more fires were being set by the ashes thrown out along the road in places where there was débris close to the track. I do not think the responsibility ought to be put onto the State or the railroad commission. I think it should be left to the railroads themselves.

Mr. ALLEN. I might add a word to what Mr. Elliott says. I wrote that section in the Oregon law, and rather purposely avoided having anything done compulsory; but apparatus must be adequate, and upon complaint any magistrate must enjoin the operation of an engine until it is proven guilty or not guilty. I never had much faith in enforcing a law against a railroad company, because it is difficult to prove anything. However, if you can shut down the engine for three or four months while this proof is being gone over the railroad does not like it.

Mr. HAWES. At the meeting of the American Forestry Association yesterday Secretary Fisher made a very interesting comment on the possibility of the transcontinental railroads being electrified within a few years owing to the development of water power. Will Mr. Allen tell us what he knows about that subject and the general one of cooperation of the railroads in the Northwest?

Mr. ALLEN. We consider electrification a logical future development, but not so near at hand, as a general thing, that we can recognize it in present plans. The present tendency is toward oil installation. The majority of our large roads burn oil through forest territory. It was forced on them in the first place by continual hammering by the Forest Service and the fire associations, but now they find it pays. Saving of labor, time formerly consumed in engine cleaning, and better steaming, as well as elimination of fire risk and damage suits, more than compensate the initial cost.

Some roads owning coal mines or interested in fostering coal towns feel obliged to use their own fuel and tell lumbermen their protests are as unfair to industry as would be a request to stop using lumber for cars and bridges. As a rule, however, these roads are good about patrol and protective systems generally and are doing their best with the spark-arrester problem.

On the whole, we consider oil fuel the solution of the question, and what frightens us most is the fear that oil will go up in price as a

consequence and also because of the withdrawing from the market of refinable oils needed in the increasing gasoline production. This is a serious contingency.

Mr. HAWES. I would like to ask Mr. Pettis what has been the experience of the railroads in the Adirondacks in regard to the use of oil—the relative expense in the use of oil and coal, etc.?

Mr. PETTIS. The use of oil as fuel for steam development eliminates sparks and cinders as a cause of fires. We know of no case where fires have been caused in New York State through its use. In 1909, when the public service commission issued its first order requiring the use of oil, the Standard Oil Co. quoted a price of $0.024 per gallon f. o. b. Albany. Last spring this price was materially increased. The railroad officials state that it has been costing them about 40 per cent more to generate steam with oil than with coal. The supervisor of equipment in our public service commission, a man of wide experience, says that this may be true, but that the difference could be reduced to from 15 to 20 per cent if the firemen were more careful in the use of the oil, i. e., did not waste it. The price of oil has advanced and may increase still further, but, on the other hand, the cost of coal is increasing, especially in the East

During the oil-burning season last year there were only two fires along the New York Central Railroad from Utica to Malone, a distance of about 170 miles, and I think both were caused by cigarettes or cigars thrown from smoking-car windows. There were no fires along the Carthage & Adirondack Railroad, which operates about 40 miles, nor along the Chateaugay division of the Delaware & Hudson Railroad.

While the use of oil is effective, a very large percentage of the fires can be prevented if the locomotives are equipped with proper devices to prevent the escape of sparks, coals, or cinders. Last year our law was changed, and its application extended from the forest-preserve counties to the whole State. The only objection of the railroad people was that they did not want the word "adequate" used in the definition of proper screens; so there was a provision put in the law that these devices had to be approved by the public service commission. Their argument was that whenever they had a damage case they did not want to bring in all the experts in the country to prove what was an adequate device. Now, before the railroads equip the engines, they submit blue prints showing exactly how they are going to fix side openings, grate rods, or the front end. Then they feel warranted in going ahead. For instance, some time ago we went to the superintendent of motive power of the New York Central, on which road there are some 4,500 engines. He fully appreciated the fire dangers and the expense due to fire claims. As a result he issued orders immediately to have blue prints prepared for different types of engines, and as the engines go to the shop the changes indicated are made, any little defect being fixed up at once in the roundhouse or at the terminals.

For the benefit of those of you who think that the number of fires can not be reduced by this method, I would like to cite a few instances. The old law limited the operation of inspected engines to forest-preserve counties and on certain lines. There is a short line from Saratoga to North Creek along which there would be no fires

for weeks, and then, all of a sudden, there would 10 or 15 a day. We would look the matter up and find the company had run in an engine which had not been inspected. In another case a short railroad had rented an engine from the Delaware & Hudson Co. This company gave the road a dead engine which had practically no screen in it at all, and there were fires continually. Therefore, if you can have the engines equipped properly, you will not have more than 5 per cent of the fires you are now having.

Another thing about railroad cooperation—if you get hold of the right man in the company you will get satisfaction. The company has its right-of-way department, motive department, operating department, and legal department, and not one of them will spend 15 cents to save the other $1,500 if they can help it. Therefore you have to go to the man higher up to issue orders and have your requests taken care of. If you go to the general superintendent or some one in a like capacity you will get satisfaction.

We wanted one line to pipe the overflows from the injectors into the ash pans, in order that whatever water was left would kill the fire in the ash pans. The company did not want to do this, but said it would put in a sprinkler. A blue print was submitted to us and was accepted. The company said that sprinklers were impracticable to use with its cast-iron pans, but we insisted, and the company yielded. A year ago last fall we told the road it could take the sprinklers out; it did so on some of the engines and left them in on others. Last fall we again advised this road that it could take them out, but we were told that it did not want to; that the sprinklers kept the ash pans from freezing up in the winter and thus prevented the engines becoming stalled on the road.

Let me make another suggestion. Do not dictate to a railroad what devices it must use. It has clever men who know more about fixing up engines than we do. Let each company work out its own plan, and if the plan is good accept it. We are not requiring the same thing on all roads, but we have a minimum requirement. We are reducing the number of fires and are accomplishing a great deal.

I do not believe that the railroads will voluntarily do the necessary amount of inspection. Also, after the railroads put these devices in shape you want to have some law that will make the employees use them properly. If wide fire-box engines are used, equipped with doors, screens, or other appliances, make those fellows use these appliances. In the case of the Lackawanna Railroad we found the engines running with the slides open. We called attention to it, and in the first instance the engineers got a lay off of 10 days and later of 30 days. Now we do not find any more open slides on the Lackawanna.

COOPERATION BETWEEN ALL PROTECTIVE AGENCIES.

F. A. Elliott, State forester of Oregon, spoke on this subject as follows:

Gentlemen: Up to 1911 cooperation between the various protective agencies in Oregon, including the Federal Government, the State, counties, railroads, and private owners, had been quite meager, although Mr. Allen, as forester for the Western Forestry and Con-

servation Association, and Mr. Chapman, as the secretary of the Oregon Forest Fire Association, had gotten a skeleton of the work started, which has been a great help to me since my appointment as State forester a little over a year and a half ago. In my first season's work during the summer of 1911 the time was very limited, but with the assistance of Mr. Chapman we organized several local forest-fire associations, each of which includes holdings in one or two counties. These associations cooperated with the Federal authorities under Mr. Cecil, the Federal district forester, and we also got some assistance from the county courts.

In 1912 we had a little more time for organization. We spent nearly all of the winter of 1911 in getting timbermen and others interested in fire protection, and, as you all know, this is a difficult task when it is pouring down rain; most of them want to begin about a month after there is real danger from fires. However, in cooperation with Mr. Chapman, fire-patrol organizations covering seven counties were perfected, thereby increasing the number of counties in which associations existed to 11. The cooperation we have had under the Weeks law has been a very great help in getting these organizations together. For instance, last spring we organized one association in Douglas County, which covers a very large area. The central part of it is mostly farming country, and on either side, both in the Coast Range and Cascade Mountains, there are heavily forested districts. Between the farming districts and these large holdings of timber are what we call the foothills, which are burned over and covered largely with brush and second-grade timber; up to this time they had received no protection whatever. As these lands came especially under the provisions of the Weeks law, I was able to take up the matter with the timbermen. I proposed that if they would organize and agree to handle all fire fighting I would appoint the man they would recommend as supervising warden for the county, and I would also give them 10 Federal patrolmen paid by the Weeks law fund. These men, together with 12 men hired by the association, gave them a large force, and the county was looked after in much better shape than it had ever been before. It cost them, I think, about a cent an acre on the holdings represented by the association. This association represents possibly from one-fourth to one-third of the timber in the county.

We organized another county which was largely timbered, and the State furnished two men—a supervising warden and an assistant supervising warden. These men were recommended by the association and appointed by the State; the State paid each of them $100 a month, and the association $50 a month additional and expenses. In that county, to get thoroughly equipped men who are acquainted with logging and cruising and are competent to handle the work of an association of this kind, we have to pay them a good salary. Two Federal patrolmen paid from the Weeks law fund were turned over to the association. The association itself hired 18 additional men, and the county court appropriated $600 and turned it over to the association for patrol work. It spent 3½ cents an acre for the protection of its timber.

In one county in southern Oregon, where we have an organization, I furnished the supervising warden and 3 or 4 Federal patrolmen

to some 12 or 15 men hired by the timber owners. The county court cooperated with us in that it agreed to furnish $500 a month for the three dry months for the purpose of fighting fires. This year it got off very easily, because we had practically no fires there, and it cost the county only $250 for the entire season. The protection cost that association about 1¼ cents an acre. Of course, all of the timbermen who enter the association come in on an acreage basis.

In regard to cooperation with the railroad companies we have, I think, succeeded very well. While none of the companies this past year put on a regular patrol, one or two had all their section foremen appointed as State fire wardens, and their train crews were instructed to stop and put out a fire if they were any distance from a telegraph office or section house. If within a reasonable distance, the train crews are to notify the telegraph operator, the agent, or the first section crew.

The private owners who are especially interested in fire-protection work in Oregon are generally large owners. We have had very little success in getting small owners interested, although in a few cases we have a number of men who own from 160 to 320 acres. The large owners, as a general rule, are cooperating not only with the State but with the Forest Service and the counties.

I want to give due credit to the assistance we have gotten from the Weeks fund, and I hope Congress will make a further appropriation. Just before I left home we had a meeting of the State Board of Forestry, and it passed resolutions, which I brought to our Representatives, asking for such appropriation.

DISCUSSION.

Mr. SYKES. I would like to ask if the locomotives on the railroads in Oregon are equipped with any fire-prevention apparatus?

Mr. ELLIOTT. On some of the logging roads, yes; but not on the main lines. We have had more trouble with fires starting from the logging roads, most of which burn wood. On the other hand, the Southern Pacific, which is the principal line running through the timbered portion of the State, burns oil altogether. The Oregon Railroad & Navigation Co. has been very good in aiding us whenever possible along its right of way; the company inspects its spark arresters carefully. I should add that some lumber companies are converting their donkey engines and locomotives to oil burners.

Mr. HAWES. I should like to say in regard to the subject of cooperation that in Vermont we have a law providing that if any landowner will build a lookout station on his land, we will put on a watchman. We have had several such stations built by lumber companies. I would like to hear from Mr. Sykes, president of the Emporium Lumber Co., as to what chances are for his company building such a station?

Mr. SYKES. We have no plans at present for the Vermont property, which includes about 50,000 acres. When we bought it, some eight years ago, it was an operating property, with seven sawmills on it, all of which were connected by telephone. The wires have since largely fallen down, so that they are not in operation, and there is no forest work done on the line. We have had no fires in eight years. It is remarkable we have been so fortunate.

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I think the Emporium Lumber Co. would cooperate with adjoining timberland owners toward establishing a lookout station somewhere on Stratton Mountain or at some other point. I consider this a matter of great importance for the protection of the forests, and will be willing to recommend to the company as soon as we hear from you about it. I trust something can be done before the dry season comes on this spring.

LOOKOUT SYSTEMS.

The morning session of January 10 was called to order by W. B. Greeley, assistant forester, Forest Service, acting as chairman, at 10 o'clock.

Mr. Greeley asked that special subjects which the collaborators wish to discuss in the afternoon session be submitted to the Chair, provision having been made in the program for such discussions.

The first subject of the morning session was "Lookout systems." M. C. HUTCHINS, State fire warden of Massachusetts, was called upon to open the discussion.

GENTLEMEN: I desire first to give you a general idea of the conditions with which we have to contend. The area of Massachusetts is 5,500,000 acres, of which from 60 to 70 per cent is wild or forest land. We have a population of nearly 4,000,000, which means that during holidays and Sundays a large number of people are traveling through the woods or along the highways in their automobiles, constantly increasing the fire danger. We have over 2,500 miles of railroad main-line trackage, with 1,937 locomotives in use. We also have 317 portable sawmills in operation throughout the State, each one leaving one or more dangerous fire slashes.

Massachusetts appropriates annually $255,000 for the protection of its forests; $200,000 for the suppression of the gipsy and brown-tail moths; $25,000 for forest fires; and $30,000 for reforestation, chestnut bark disease work, and office expenses.

The fire loss in Massachusetts for the year 1911 was $537,749. During the three preceding years a conservative estimate of the fire loss would not be far from $300,000 each year. In 1912, with a rainfall of 7.36 inches less than in 1911 and 8.61 inches less than normal, our reports show the fire loss to be only $80,836. The reports of our lookout watchmen show that over 2,200 fires have been observed, of which about 400 were permit fires or fires estinguished in their incipiency by the forest wardens. The forest wardens reported 1,851 fires, over 1,500 of which were first observed by the men in charge of the lookout stations. Of the latter, 51 per cent were extinguished within an hour from the time they were observed, 21 per cent within two hours, 15 per cent within three hours, 5 per cent within four hours, 3 per cent within five hours, and but 5 per cent burned over five hours, many of which were peat-bog fires.

We have in Massachusetts what is called the town forest-warden system. Each town, of which there are 354, has a forest warden, who is appointed by the selectmen of the town and approved by the State forester. Each forest warden appoints necessary deputies, distributed

throughout the forest area of his town; there are 1,640 such deputies, of whom 1,135, in addition to most of the forest wardens, have telephone communication with the observation stations. Owing to our forest-fire appropriation being limited, we have found that better results would be obtained by devoting our funds to the establishment of observation stations rather than a paid patrol force. The State has been divided into four forest-fire districts, each in charge of a competent fire warden. These wardens are provided with automobile runabouts, and practically all the patrol work in the State is done by them. They have general supervision over the town forest wardens and the observation stations in their respective districts, and during the coming season will devote considerable time to the inspection of locomotive spark arresters and ash pans.

The portion of the State shown on figure 1 as districts 3 and 4 comes under the cooperative agreement with the Federal Government. In this territory our fire loss in 1912 was about $35,000, as compared with about $400,000 in 1911. We have within this territory 163 forest wardens and 770 deputies, 512 of whom are connected by telephone with our observation stations.

We have had in operation during the past season 17 observation stations, located on the highest elevations throughout the State. Each station is in charge of a competent local watchman, who knows every elevation, railroad, highway, and the exact location of every forest warden and deputy. We have erected 30, 40, or 50 foot iron towers, especially designed for forest-fire work. These are set on cement piers, and at the top of each tower is an 8 by 8 foot wooden or steel structure, as far as possible inclosed in glass. (See fig. 2.) The steel of the 30-foot tower costs $120; the materials for the wooden structure at the top, including windows, cost about $75. The construction and cement work is done entirely by our own men. Three men will make the cement piers in about two days; four men will put up the tower in from one and one-half to two days; and two men will build the wooden structure in about three days.

Each station is equipped with long-distance telephone connection with the New England telephone system. We have had some delays during the season, owing to being on party lines, but this has been eliminated in two or three instances by having a line run to the central office. Arrangements are now being made so that practically every station will have its own private line for use the coming season.

The stations are each equipped with a map stand, elevated 3½ feet from the floor, on which is a topographical sheet covering the territory within a radius of 15 miles from the station, with the town boundary lines plainly marked. These maps also have on them a table of degrees for use in crossing lines, one station with another, and each station is furnished with a large map of the State showing where each 2-degree line drawn from that station will cross similar lines from other stations. There is communication between the lookouts, and our triangulation system of locating fires has worked out very successfully between many of the stations. We have found during the past season that it is absolutely impossible to thoroughly cover a radius of 15 miles from our stations during hazy and smoky weather. We shall, therefore, add several substations to be used during the spring and fall, thus reducing our radius to 12 miles at most.

Better results would be accomplished if this could be reduced to not over 10 miles.

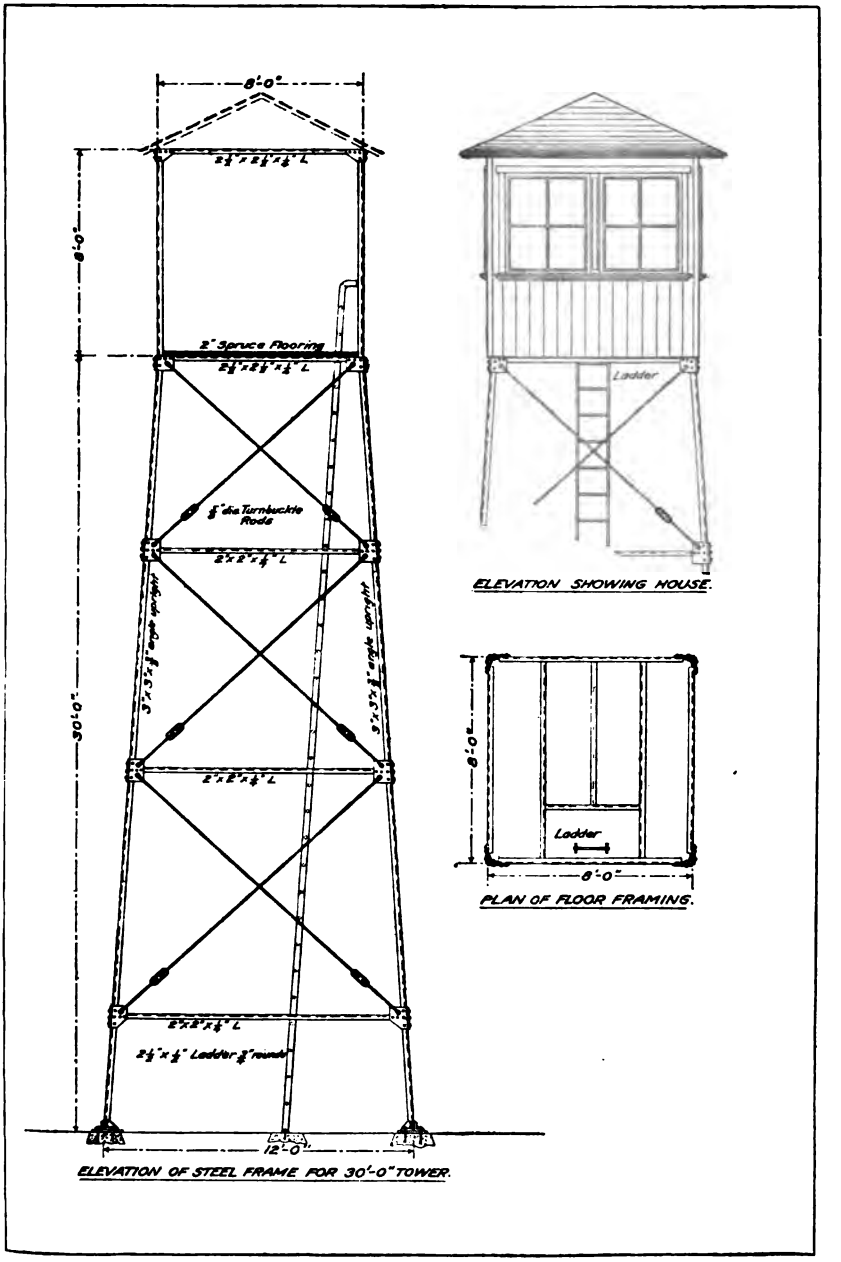


FIG. 2.—Observation tower designed for Massachusetts Forest Department.

In selecting the watchmen for our towers we have made it a point to employ local men who are familiar with the territory under their

supervision and who are personally acquainted with the town forest wardens. These men are on duty from 7.30 a. m. to 6.30 p. m. During the portions of the season when not required for observation work their time is devoted to building fire lines, clearing out trails, repairing and trimming out their telephone lines, and visiting the town forest wardens and deputies throughout their territory. Many of our stations are supplied with a watchman's time clock. This is punched every half hour, and has proved very effective. We also check up our observers' reports with the reports of fires received from the town forest wardens, in order that we may ascertain whether or not they have promptly reported each fire.

The cooperative work carried on between the State and the towns has been very gratifying. Several towns have contributed one-half and others have contributed the entire purchase price of an observation tower. We shall erect four towers this spring that have been purchased in this manner.

We have an annual appropriation of $5,000 for forest-fire equipment. All towns with a valuation of $1,500,000 or less are entitled to 50 per cent reimbursement from the State on all equipment of this kind they desire to purchase not exceeding $500. The equipment is approved by the State forester and placed under the supervision of the town forest warden subject to inspection at least once a month by the State fire warden or his authorized assistants. Our reports show that the total amount expended by the State and towns for such equipment in 1912 was nearly $24,000, including sums expended by the larger towns that do not come under the reimbursement act.

There are two other matters I wish to speak of—the cooperative work with the rural mail carriers and the boy scouts. As soon as the order was issued requiring rural mail carriers to report all forest fires we at once supplied each carrier with a list of the forest wardens to whom he was to make report. We have had 85 fires observed and reported by such carriers, and several fires have been extinguished by them in their incipiency.

We have also taken up the matter of interesting the boy scouts in the forest-fire work. There are about 7,000 scouts throughout Massachusetts, divided into 250 separate companies. Early in the spring we supplied each scout master or assistant scout master with a copy of our fire law and instruction book, thus enabling them to instruct the members of the different companies relative to the forest laws. We have had no fires caused by boy scouts, and it is but fair to assume that the educational work done through the scout masters has prevented many fires.

DISCUSSION.

Mr. GREELEY. What is the relation between the lookout watchman and the patrol force? When the lookout observes a fire what does he do?

Mr. HUTCHINS. As soon as the fire is accurately located the observer calls up the town forest warden or the deputy warden residing nearest to the fire.

Mr. WILBER. Do you have any trouble with what you might call false fire alarms—a man calling out the warden to go to a fire when some one is burning brush?

Mr. HUTCHINS. Yes; we have had some trouble along this line caused by our forest wardens not notifying the observers at times when permits are issued.

Mr. WILBER. Who owns the property your towers are located on?

Mr. HUTCHINS. In some instances the State, in others private individuals. There has been no objection by private owners to our cutting trails and running telephone lines through their property. Our lines are practically all run on trees, and we use a heavy triple braid No. 9 wire. This wire costs us $30 a mile, and three men will run a mile of wire a day.

Mr. WILBER. Are the forest wardens in touch with telephones?

Mr. HUTCHINS. In most cases they are men we can get very promptly. In case we are unable to get the forest warden we are always sure of getting in communication with at least one of the deputies. Our observers make it a point to get in personal communication with the forest warden or deputies.

Mr. WILBER. Do you have trouble with the fall fogs or mist that hangs over the hills?

Mr. HUTCHINS. We experience this trouble more or less throughout the Cape country. We also had trouble at the Greylock station by being shut in with clouds, owing to the elevation.

Mr. ELLIOTT. Our legislature will soon be in session, and we have to go before it for another appropriation. I want to call your attention to the difference between our State and Massachusetts. The area of Massachusetts is something like 5,500,000 acres. We have 61,000,000 acres, of which there are probably 40,000,000 acres of either timber or brush land which needs protection. We are getting a little appropriation of $30,000. I buy my own automobile to inspect the whole State. I want to get a map of Massachusetts and a thorough report on that State to report to our legislature. I think it will be good information for it.

Mr. RANE. There is one thing Mr. Hutchins has not touched upon; in fact, there are many things he has not had time to touch upon. One thing we did that I think has not been mentioned was to get out a forest wardens' handbook which contains the names of every warden, his deputies, and the telephone number of each. We started out with the idea of distributing these handbooks through the automobile association in the State. They are pretty enthusiastic people over forestry, particularly from an esthetic standpoint, and where we have a publication of this sort with the names of all the towns alphabetically arranged, any automobilist going through the State, if he is interested at all, should there by a forest fire, has an opportunity to be of assistance. With one of these books an automobilist, if he comes across a fire, simply has to see what town he is in, then stop off at the first farm house that has telephone connection and report. The same use can be made of this book by those operating electric lines. Rural mail carriers and the boy scouts are also making use of it.

J. H. FOSTER, professor of forestry at New Hampshire College, who has been intimately associated with the protective work under

the Weeks law as a Federal inspector, was called upon to continue the discussion of lookout systems. He said:

GENTLEMEN: To my mind lookout work is so important that as time goes on other lines of fire protection will become less necessary. I say this with a full understanding of the shortcomings of lookout stations and with the full knowledge that there are times when smoke and haze render them useless for short periods. In order that lookout stations may render the best service they must, of course, be efficiently equipped and maintained.

Last summer I visited a great many of the stations in New England and was much impressed with the quality of the men employed as observers. They were accustomed to the region about them, were acquainted with the people, and most of them were experienced in woods work. Furthermore, they enjoyed the life of isolation, which is, of course, essential to satisfactory service.

I am sorry to say that in a number of cases I found that the district chiefs neglected the lookout men under their direction. They should keep in touch with the lookouts daily if possible. It is discouraging for an observer never to see or seldom to have communication with his district chief. While it may be impossible for a district chief to get to isolated stations often, he can telephone to the men, which is not only encouraging to them but helps him to gauge the efficiency of the service they are rendering. It is not enough for the observers to make written reports to the district chief. They should come personally in contact with him.

The need of easy communication from lookout stations to central telephone offices is absolutely essential. The lack of satisfactory communication in some instances has been responsible for bad fires. It is perfectly obvious that unless an observer can communicate without delay with the central telephone office and with his district chief or a fire warden the lookout station might just as well not exist. I know of one station with an excellent observer and in a region where great service could be rendered, but because the observer could only get the central station by relaying a message through a store he was in one instance unable to report a fire until it was already discovered by other people and beyond control. In some cases direct communication with central telephone stations is not possible at present even where the lookout is a very important one to maintain.

The Kennebec Valley Protective Association in Maine is rendering fine service in aiding the State in its fire-protective work. This association has recently completed a double telephone line connecting isolated portions of the Kennebec watersheds and so located that lookout stations may be readily connected and brought into close touch with the chief wardens in charge and the secretary of the association. Its work in other directions, such as furnishing funds to the State in time of emergency, is also very valuable.

In New Hampshire the timberland owners' association is doing effective work, not only by protecting large areas belonging to the owners, but by helping the State forester and the Federal Government to improve the entire fire service. Assistance rendered by this association is doubly important because of the fact that its funds can be used for any legitimate purpose and are often used to supply needs which the State and the Federal Government can not supply.

The association has built many lookout stations and equipped them and has used its funds in other ways, such as building lines of telephone to connect isolated points and paying for extra telephone service.

I am very enthusiastic over the lookout-station work which has been developed in Massachusetts. The ease with which one may communicate from one station to another and with central telephone offices makes it evident that any fire must be quickly reported. It is a policy of Massachusetts to have the observers come in close touch with the town fire wardens. The district chiefs during periods when there is no fire danger take the observers to the surrounding towns and make them acquainted with the wardens. In this way many important problems are discussed and plans made which help to increase the efficiency.

A great deal has been said about railroad patrol and the protection of property from railroad fires. I believe lookout stations can render an extremely important service in this regard, and they are already doing so to a certain extent. I believe the time should come soon when lookout service may do away more and more with the need of railroad patrol. A number of instances in New England show what excellent results have been obtained in checking fires along railroads by means of lookout stations. In Connecticut one of the stations in particular is so situated that many miles of the Central New England Railway can be seen from it. The observer has been able to call up the railroad station agent and report to him that a particular train has just started a fire, and the station agent has been able to get the section crew to the fire at once. Many miles of railroad can be seen from some of the lookout stations in western and central Massachusetts and also from stations in New Hampshire, particularly Black Mountain and the Mount Agassiz stations. In Maine the lookout stations are in a large measure located in a portion of the State where railroad fires are the greatest danger.

With reference to brush permits, a number of cases came to my attention last summer where the observer at a station was undecided whether or not to report a fire which was obviously a brush fire and in no danger of spreading. It would be well if fires set by warden permit could be reported to the observer either by the fire warden or by the person receiving the permit to burn brush.

Lookout-station work is comparatively new. It is being improved every year, and I am confident that a greater degree of progress in fire protection has been made as a result of lookout and patrol work in the last two or three years than has ever been made before or could be made by any other means.

TELEPHONE CONSTRUCTION.

C. R. Pettis, superintendent of forests of New York, led the discussion on this subject, as follows:

Gentlemen: Our appropriation for fire protection applies to forest lands in the Adirondack and Catskill preserves. The money may be used for employing men for either patrol or fire fighting and their expenses, purchasing supplies, building lookout stations and telephone lines, or other necessary purposes. The financial aid from the Federal

Government has been used to pay the salaries of observers on lookout stations.

The region protected is divided into five districts—four in the Adirondacks and one in the Catskills. These districts include certain towns known as "fire towns," of which there are 77 in the Adirondacks and 19 in the Catskills; their aggregate area is 7,200,000 acres, including 1,644,088 acres of State land.

I think you are all convinced of the value of observation stations. In New York I believe we would not be able to maintain any kind of reasonable fire protection without them, and, of course, we can not have effective stations without telephone connections. Stations are being established as fast as our appropriations and facilities permit. In this work we have had the cooperation and financial support of private owners. In some cases we enjoy the free use of their telephone lines or they have joined in building new ones; in other cases complete stations have been built by the owners and we maintain the observers.

The first work we did in constructing observation stations and telephone lines was in the summer of 1909, when we established 11 stations. Since then we have been working on a comprehensive plan, and to-day there are 49 stations. We hope eventually to have about 60 stations probably not more than 7 or 8 miles apart.

We have already constructed 227 miles of telephone lines, of which 58 miles was built the past year almost entirely by the ranger force during the winter season. In some cases these lines are comparatively short, built to connect the station with a commercial line or to form a connecting link between existing lines, while in other cases they are from 30 to 40 miles in length. On some of the longer lines we are leasing a large number of phones which not only bring in a revenue and help pay the maintenance charge, but also put the force in touch with a greater number of people.

We build a two-wire line (metallic circuit) wherever we connect with one, and similarly in the case of a one-wire line (grounded circuit). We clear out a space along our lines and always attempt to go through green timber, if possible. If we have to go through fire-killed timber outside of State land, we try to make some arrangement with the owner to cut down the necessary trees so that they will not be constantly falling on the line. Only in cases of necessity do we erect telephone poles. We think it cheaper, if a telephone company has a line of poles where we wish to establish a line, to make an attachment contract; as a rule, there are unused pins which can be rented. The customary price is 10 cents per pin per year.

No. 12 galvanized-iron wire is used for lines attached either to poles or trees. This material costs approximately $6 a mile. When lines are attached to trees we use Victor split insulators, the wire going through the center of the insulator, around which a short wire is wrapped, securely turned, and then attached to a tree by an ordinary fence staple. The insulators are placed approximately 150 feet apart, requiring 35 to the mile. The opening in the insulator is sufficient to permit the wire to slide, but as the line is built with some slack a tie around the insulator is made once in about every seven insulators. This tends to distribute the slack and prevents the wire from dragging on the ground. In case a tree falls on the line it is not broken, but simply pulls up the slack. When the tree is removed

the slack is redistributed. It is desirable to run the line near the trail in order to make inspection easy for the linemen. The lines through the woods are not built straight, but in a somewhat zigzag manner. This construction holds the wire out from the trees. If a metallic circuit is constructed, the lines should not be so close together that a tree might fall across both of them and thus make a short circuit.

Special attention should be given to the matter of protection from lightning. Mountain tops are very often "hit." A heavy protector should be used in all cases. The 58–A of the Western Electric Co. has proved very satisfactory. The observer should be provided with several additional fuses. We have also found that the use of a switch disconnecting the wire before it reaches the instrument gives an additional precaution; it should be opened in case of thunderstorms.

In purchasing instruments it is desirable to specify a 2,500-ohm ringer, as this increases the sound. Metallic telephone sets are being tried and will probably be desirable. In any case the sets should be carefully protected, not only from storms but from hedgehogs.

Subsidiaries of the American Telephone & Telegraph Co. (Bell) are our chief operating companies, and whenever we connect with their lines our agreements provide that we make the necessary construction subject to their inspection. We have had no trouble at all on this score, because we endeavor to build substantial lines.

The cost of construction varies in the case of a one-wire line (grounded circuit) from about $10 per mile of tree line to $40 per mile of pole line; and in the case of a two-wire line (metallic circuit) from $20 per mile of tree line to $60 per mile of pole line. Where there is no forest growth we have in cases found it advisable to use what the Western Electric Co. call No. 9 O. K. triple-braid galvanized-iron wire, costing $30 a mile. I have heard of cases where this wire has been in use for eight or nine years, lying on the ground, and is still giving satisfactory service. It is particularly adapted to use on mountain tops where there is nothing but barren rocks and it is impossible to erect poles.

As Mr. Hutchins pointed out, it is very desirable, if possible, to get a direct connection. Do not have your telephone wires so that the man on the mountain station has to wait for somebody to run across the road to telephone to somebody else, or where you can not talk to the fire warden. If your station man is any good he may tell his ranger or warden something in regard to the size of the fire and how it is coming up, so that the ranger can get an idea of how many men he needs to take; those are the important things.

Wherever possible our lines are connected to lumber camps. In fire fighting one man from a lumber camp is worth 25 men picked up around a village. The lumber companies in nearly all cases have telephones running into their camps. They give us free use of these and switchboard service wherever necessary, and all we have to pay is our long-distance telephone rental.

It never seemed to us quite fair to ask a commercial company to build a line to the top of a mountain to get the business that would come from the operation of a single telephone, and therefore we went ahead and built our own lines. We furnished our own instruments and maintained these lines, and there is no additional expense to the telephone company for the new business. We use the telephone prob-

ably seven months in the year and pay the regular full annual telephone rental. That rental varies, according to the size of the telephone exchange, from $18 to $36 a station a year.

Mr. FOSTER. May I ask if the telephone companies give you a rebate for a half-year or more?

Mr. PETTIS. They are willing to have a contract canceled on payment of one-half of the rental for the unexpired period. They have offered that option.

In the case of two lookout stations we have our lines on toll-service basis; that is, drop the money in the slot when we use the telephone; they offer contracts for such service on toll lines only. In another case, at Tupper Lake, we built our line from the top of the mountain to the telephone central station, where we are on a regular toll basis and pay whatever the prescribed toll rate is.

We have had most of our trouble with party lines. A great many lines were so heavily loaded that it was not desirable to add another telephone. One case of this kind was where we had four mountain stations and five rangers on a long and heavily loaded line. In this instance we have signed a contract with the Bell Telephone Co. to attach our line to their poles, and have run a wire to handle our employees, who now get service among themselves direct on our own line or through central to others. Private owners have cooperated with us very fully. We built from Schroon Lake to Underwood, a distance of nearly 30 miles, a line which ran into the telephone central at Schroon Lake; a private party paid one-half of the expense and looked after all the maintenance.

The telephone companies have insisted that we pay business rates, while we have tried to show them that we were not doing business, but that the service is the same as that supplied a private house, because our phone was at the habitation of a single man on a mountain station. On some of our mountains we have two telephones, one on top of the mountain and one down a short distance at the camp. We have maintained that one telephone was an extension of the other, for certainly one man, even though he does have two telephones, could use but one at a time.

The telephone companies derive a great deal of revenue from the State's fire-protective organization. All of our 49 mountain stations are called every day by the district ranger. The tolls will vary from about 20 cents to as high as 40 cents a call.

So much for telephone construction. Before concluding let me say a few words about mountain stations. We have tried to make them an attraction in the locality in order to get the tourists interested. We have cleaned up the trails so that ladies can go up some of the mountains, and we have posted signs so that tourists can not get lost. The station is thus made much more attractive for the observer; he is not so lonesome. All this aids the work.

I wish to point out a single instance as to the value of a mountain station. During the dry period of last July, about noon one Sunday, a fire was discovered by the observer on Adams Mountain. It originated in one of the most inaccessible portions of the Adirondack forest, but in spite of this fact a fire warden with a small force of men reached there within two hours. By 5 o'clock the following morning the ranger was on the ground with a large force of men, and

the fire was controlled before it had burned over more than 5 acres. The land on which this fire occurred had been lumbered within recent years, and there was a large amount of slash on the ground. If the observation station had not been there it is probable that thousands of acres of timberland would have been burned over before the fire could have been checked.

The time to fight a fire is before it starts. We supply our stations with United States Geological Survey maps, but few of our men use them. We select for an observer a man who has tramped all the ridges and points and knows his own territory. When he learns of a fire he calls up the proper persons and gets them on the job. They get an automobile, or whatever is required, and put the fire out before it gets well started.

Last year we had 383 fires in the forest-preserve counties. The total acreage burned over was 6,990, of which 629 acres were State lands, and the total damage was only $11,340. The average area per fire was 18 acres, and the average damage about $30. Out of the area under protection about one-tenth of 1 per cent was burned over, and but a very small proportion of that was land upon which there was much timber. A large proportion of our fires occurred around the outlying sections of the Adirondacks. We are having most trouble there, and also in the sparsely settled portions along the highways.

Mr. GREELEY. Gentlemen, I have here some copies of a proposed contract[1] between the American Telephone & Telegraph Co. and the Secretary of Agriculture. We are extremely fortunate in having with us to-day Mr. M. C. RORTY, commercial engineer of the American Telephone & Telegraph Co., who has come here for the especial purpose of discussing the provisions of this contract, which may apply to the States as well as to the Federal Government, and such matters pertaining to telephone contracts and rates in general as you may wish information on. I take pleasure in introducing Mr. Rorty.

Mr. CHAIRMAN AND GENTLEMEN: Perhaps what I have to say can be introduced in the best way by telling just how this present contract has been developed and what the thoughts are as to the use of it, or of similar contracts throughout the several States and in the various portions of the country.

This particular agreement has been approved by the Secretary of Agriculture and has also been approved by the American Telephone & Telegraph Co., to the extent that we agree to advise its adoption by the various associated telephone companies.

I may, in this connection, make a little explanation as to the relations between the American Telephone & Telegraph Co. and the associated companies. The associated companies are separate and independent organizations except as to the stock interest that the American Telephone & Telegraph Co. has in all of them. That stock interest runs, in different cases, from a minority interest to complete or nearly complete control.

Contract forms similar to these will be forwarded to the associated companies as soon as completed copies are received from the printer, which I expect will be some time next week; and I have no doubt that the form will be adopted substantially as it stands, in so far as the Department of Agriculture may wish to have contracts executed.

[1] A copy of this contract form is contained in the Appendix, p. 80.

The contract has been drawn up specifically to meet the interests of the Federal Forest Service. Nevertheless, we have had in mind, in drawing it up, that there would be a desire on the part of the various State foresters to arrange for somewhat similar contracts, and, while the details will necessarily have to vary in the different States according to local conditions, nevertheless I think it is safe to say that the spirit of this agreement—the general spirit of cooperation in which it has been written—will be carried out in connection with any separate contracts that may be set up between the State forest departments and the local Bell telephone companies.

The essential feature of this contract, as between the Secretary of Agriculture and any associated Bell telephone company, is the agreement of the telephone company to establish for forest purposes practically the same type of service that is now furnished for rural telephone lines. The service may, however, by local arrangement be set up on a one-party-line basis if there is objection to having other parties on the forest lines, or there may be three or four or a dozen Forest Service telephones on any one line. The plan is expressed in general terms in this contract, with the idea that the schedule specifying the compensation will cover the details and will be taken up individually in the territory of each telephone company.

Provision is made, in addition, for a reciprocal use of attachments on Forest Service pole lines, and the pole lines of the Bell Telephone Co. These attachments are to be interchanged without charge, subject to the condition that there shall be spare facilities available in either case.

The telephone company also agrees to construct telephone lines for the Forest Service in any locality it may desire; to install telephones and perform maintenance work; and, in emergency, to sell to the Department of Agriculture such telephone equipment, line material, and supplies as can be reasonably supplied from local stock rooms of the telephone company, this service to be furnished at cost, including all supervision charges, plus 10 per cent, and the sales to be made at actual cost plus 10 per cent. It is a question just how far the Forest Service may desire to avail itself of this last provision, but it is at least desirable to have the arrangement set up in advance, so that when an emergency comes there may be no delay on account of special negotiations.

A further clause provides that the Department of Agriculture may attach telephones for lookout stations on the telephone company's pole lines and circuits without charge, but subject to certain restrictions that are enumerated, such telephones to be for emergency use.

Provision is also made for the connection of portable stations with subscribers' lines, and for the designation of local telephone officials who shall cooperate with the officials or employees of the Forest Service in connection with all telephone work. The telephone company agrees to furnish maps, blue prints, drawings and specifications, and recommendations in connection with the construction of forest telephone lines, and also agrees to cooperate actively with the officials and employees of the department in providing emergency communication by telephone during forest fires. This last provision will mean a great deal, I imagine, in a case of a large fire, and the intent of the section is to make sure that some one telephone man shall know that it is his job to cooperate with the local forest people

and to make things go properly as to the use of telephone service in controlling the fire.

The telephone company also agrees to keep any public telephone exchange open at all hours on payment of the actual extra expense involved. It may be that when a fire is burning furiously constant telephone communication will be necessary. In such cases the telephone company will keep the small telephone exchanges open all night or on Sundays and holidays. A great many of the smallest exchanges are open only until 10 o'clock, or about that time.

Another provision allows telephone calls made from subscribers' stations or portable stations to be charged to any telephone of the Forest Service, provided the telephone in question is either the one called or is one connected with the local exchange. In some cases there are local rules against reversing calls. This section makes it always possible for Forest Service employees to reverse toll calls to Forest Service telephones, and also permits them to have calls charged from an emergency station to any Forest Service telephones connected with the exchange at which the calls originate.

Another section provides that the telephone company will use its good offices in arranging, so far as possible, with its subscribers in or near any National Forest to give prompt notice to the telephone company's central office directly serving such subscribers of any forest fires discovered by such subscribers or of which they may receive notice, and will instruct its operators and other employees promptly to communicate such notice to the local forest officials. This gives you something in addition to the boy scouts and the rural mail carriers, and, I imagine, with a little careful work can be extended into a very valuable patrol system.

Another section provides that the telephone company shall furnish maps showing the arrangement and location of circuits, pole lines, and exchanges of the telephone company in the neighborhood of any National Forest.

Still another section provides that the telephone company shall use its good offices to secure for the Department of Agriculture, upon terms and conditions substantially similar to those provided for, suitable arrangements for the furnishing of similar service by such of the connecting companies of the telephone company within its territory as the Department of Agriculture may in each case desire or approve. This section simply means that the telephone companies will use their acquaintance with the telephone companies over which they have no actual control in the interest of the Forest Service. In the case of connecting telephone companies that have been doing business with the associated Bell companies for any length of time, there will probably be very little difficulty in making any arrangements that may be desirable.

A special provision in the contract which should be of particular interest to the State foresters is covered by section 14 of Article I, which states that the telephone company will "extend the telephone facilities and service covered by this agreement to State authorities and private timberland owners cooperating with the Department of Agriculture in forest protection in so far as, in the judgment of the telephone company, such facilities and service may reasonably be so extended: *Provided*, That any special rates for exchange or toll-

line service set forth in the annexed schedule A shall in no case hereunder be allowed to such State authorities and timberland owners for any purposes other than forest protection."

This clause was inserted to cover cases where State authorities or private timberland owners were directly cooperating with the Federal Forest Service in the protection of forests adjacent to existing National Forests. It had not in mind the cooperation that exists between the State forest departments and the Federal Forest Service under the Weeks law. The latter condition may, however, be met by the negotiation of contracts, substantially similar in general intent to that before us, between the State forest departments and the associated Bell telephone companies. However, such contracts must be negotiated in detail with the associated telephone companies and not with the American Telephone & Telegraph Co.

The only remaining section of particular consequence in the contract is that which provides for the furnishing to the telephone company of right of way through National Forests under certain specified conditions.

As to specific telephone rates to be charged under this contract, the present arrangements of the Forest Service with the associated companies vary widely, and it is not expected that the adoption of the new form of contract will necessarily require any modifications in the existing charges. All such matters will be questions for local negotiation and will be covered by the schedule in each case. It is hardly possible for me to indicate what the attitude of the local telephone companies will be in regard to any specific rates, although it is the expectation, in a general way, that the charges for forest telephones will be more or less in line with the charges made in each locality for rural telephone service on lines where the subscribers furnish their own instruments and the rural portion of each circuit. Such charges vary widely in different parts of the country, ranging from as low as $3 up to as high as $12 per station per annum for a minimum of about six stations on any one line. A very common rate is in the neighborhood of $5 or $6 per station. Additional charges are made, of course, in cases where the telephone companies furnish the instruments.

Mr. Pettis has raised a point in connection with the charges for service rendered during a part of each year which may need some explanation. From the telephone company's standpoint it is difficult to figure that service of this kind, particularly where it is required every year for a definite period, costs any less than service that is continuous through the 12 months. The switchboard apparatus, cable pairs, and outside wires, even when not actually in use, have to be held in reserve and maintained; and operators and repair men have to be provided to handle the maximum amount of work to be done during any part of the year, and can not very well be laid off simply because service at a few telephone stations is discontinued during the winter months. The result is that the rates for so-called "short-term" service have ordinarily been a compromise between this view of the situation and the subscriber's point of view that he should not pay for telephone service except when actually using it. Charges of

this kind become, of course, of less importance in cases where the Forest Service furnishes its own circuits and instruments.

The only general statement that can be made in regard to rate matters is to repeat what I have said before, that the present contract has been conceived in a spirit of liberality and cooperation, and that it is quite certain that the same spirit will be carried out by the telephone companies into any individual negotiations that the State foresters may undertake in their respective States.

CONSTRUCTION OF PROTECTIVE IMPROVEMENTS IN WISCONSIN.

J. G. PETERS read the following paper from State Forester E. M. Griffith, of Wisconsin:

GENTLEMEN: In 1910 there were only a few roads within the State forest reserve. As a complete system of roads, fire lines, and telephone lines was absolutely necessary in order to protect the reserve from fires, this work has been pushed during the field seasons of 1911 and 1912 as rapidly as the men and funds at the disposal of the forestry board would permit.

Within the reserve there were fortunately many miles of old logging railroad grades. With a comparatively small amount of work many of these have been made into very fair woods roads, which will also be excellent fire lines. Others are so located that they can not be used as roads, but most of them will be cleared of brush and other inflammable material.

Approximately 159 miles of road were built, at an average cost of about $118 per mile. Where old railroad grades could not be utilized, roads had to be built through heavy brush or timber. The cost of building a typical piece of road on an old railroad grade was as follows:

Character of work.	Total cost; distance, 8 miles.	Cost per mile.
Cutting brush	$56.85	$7.11
Removing ties	58.08	7.26
Removing rock and sod	9.20	1.15
Plowing and dragging	49.85	6.23
Board of men	85.90	10.74
Board of team	33.40	4.17
Total	293.28	36.66

On most of these old railroad grades the brush is very thick. This must first of all be cut out to make a good wide road, then piled, and later burned. The heaviest part of the work is removing the ties, often birch, which have become firmly embedded in the turf. They are piled up along the road and, when thoroughly dry, burned. After the rock and sod have been removed the road is plowed and dragged, and then with a little use it packs firmly.

It is interesting to compare the cost of a road built through very brushy country with that of one built on an old railroad grade, es-

pecially as the work was done under the same forest ranger with practically the same crew of men:

Character of work.	Total cost; distance, 2.75 miles.	Cost per mile.
Cutting brush	$113.95	$41.44
Removing stumps	44.85	16.31
Plowing and dragging	32.20	11.71
Scraping	70.05	25.47
Shoveling and grubbing	125.70	45.71
Dynamiting	19.00	6.91
Burning brush	26.45	9.62
Board of men	215.30	78.29
Board of team	86.95	31.62
Total	734.45	267.08

Approximately 118 miles of fire lines have been made, at an average cost of $87.70 per mile. Most of the fire lines follow the old railroad grades. Many of them are really secondary roads, and can be used as such when desirable. However, in a great many places it has been found necessary to construct fire lines where there were no railroad grades, and in such cases the fire line has always been built so as to connect two lakes, or a lake with a river, road, or other boundary, from which the fire could be fought. The forest reserve contains several hundred lakes besides a number of rivers and many smaller streams, which makes it a comparatively easy matter to divide the reserve, by means of roads and fire lines, into a large number of blocks or districts, so that a forest fire can be held in the district in which it starts.

Fifty-six miles of telephone line has been constructed, at an average cost of $36.77 per mile. The detailed cost of an average line was as follows:

Character of work.	Total cost; distance, 9 miles.	Cost per mile.
Cutting and skidding poles to road	$78.30	$8.70
Digging holes, hauling and setting poles	75.60	8.40
Stumpage value of poles	40.50	4.50
Stringing wire	49.12	5.46
Cost of wire	43.38	4.82
Cost of knobs	2.70	.30
Cost of nails	.54	.06
Total	290.14	32.24

Our telephone lines extend from a headquarters camp to ranger cabins, lookout towers, and near-by towns; a switchboard at the headquarters camp makes it possible to connect any of the lines.

During the summer of 1912 four 55-foot steel lookout towers were built on some of the highest hills within the forest reserve, so located that nearly the entire area of forest-reserve lands in Oneida and Vilas Counties can be observed.

The average cost of constructing the towers has been $136.90, the detailed cost of a typical one being as follows:

Cost of tower	$66.32
Labor setting up tower	52.51
Cement for foundations	9.55
Lumber for platform	3.05
Total	131.43

From any of the towers the country can be seen for 10 miles in almost any direction, and during dry weather an observer is stationed at each, who reports immediately by telephone any fire or smoke that may be seen.

Old dead stubs are one of the most prolific means of spreading forest fires, as the fire quickly runs up the dead bark to the top of the tree, and a slight wind will carry the burning bark for long distances across roads, fire lines, streams, or other barriers. Stubs of this kind, chiefly birch, have been cut back for 6 rods on each side of 83 miles of roads and fire lines, at an average cost of $5.34 per mile.

Where the slash from old lumbering operations is very heavy, and especially where it adjoins timber or other valuable property, it is necessary to pile and burn it. Over 1,335 acres of dangerous slashings have been destroyed, at an average cost of $4.88 per acre. The reason the cost was so high was on account of the work being done on the worst areas where the slashings were heaviest, and also because the lumbermen had made no attempt to pile the slash.

SLASH DISPOSAL.

W. T. Cox, State forester of Minnesota, addressed the conference on this subject, as follows:

GENTLEMEN: The forest service in Minnesota has two big problems—in the summer, fire patrol, and in the winter, slash disposal. The summer force is reduced in the fall to about one-half. We find it necessary to retain the complete force of district rangers and from one to three assistants in each district to look after slash disposal. There are over 1,500 logging camps operating in the northern part of Minnesota this winter, not including the small hardwood operations. It can readily be seen that it is a big job for the rangers to handle this enormous amount of work and to go around to all of these different operators, a number of whom are small contractors, many being irresponsible and requiring supervision. The larger outfits, of course, can be supervised less closely, because they are responsible people, and we can get back at them if they fail to dispose of the slash properly. The law is a very broad one and most satisfactory. It leaves to the discretion of the forest department the whole mater of how the slash shall be disposed of. The old law stated that the slash must be burned, and set a date before which it must be fired. That law was inoperative not only because of the failure of the State to provide the men to enforce it, but also because it was so drastic that it could not have been enforced; it was an impossibility and would have put the loggers out of business.

We have many different conditions in the State, various types of forest and kinds of soil, and they all have to be considered in making rules regarding slash disposal. I might mention some general rules or practices in regard to the handling of slash. In the northeastern part of the State there is considerable spruce and cedar, and the soil between the hills is very rocky and swampy. Under such conditions we require the operators—largely small contractors—to lop their slash and make fire lines around it; in general, no burning is required. This kind of work can be done for approximately 20 cents a thousand board feet, or its equivalent, since the slash is cut into poles, posts, and similar products. In this part of the State there are also large areas of mature white and Norway pine, growing mainly on the rocky ridges. Here we require the slash to be burned in winter as logging proceeds. There was a great deal of opposition to this at the start, because it looked like a very drastic measure. But we have had meetings with the lumbermen, and they now feel that it is their own work, which it really is. They have finally come around to our point of view, and many of the larger companies are burning the slash clean at a cost of from 5 to 20 cents a thousand feet. The lumbermen, as a rule, are reasonable, and at one of the meetings they agreed as a body to expend in slash-disposal work not to exceed 30 cents a thousand feet for their operations in order to reduce the fire risk. Some companies state that they are burning the brush at a profit, because it reduces the cost of skidding and they now find all of the logs. We want the brush burned in the winter or early spring while the cutting is actually going on, because if it were piled for burning later on the light soil or duff characteristic of this very rocky country would likely be burned off and destroyed, practically ruining the country.

In other sections of the State we employ different methods. For instance, in the sand-plain country of central Minnesota there is no reason why the brush can not be piled as logging proceeds and burned in the spring. Some loggers claim they can dispose of it more cheaply in this way, but others consider that they can burn it as logging proceeds just as cheaply, or at even less expense.

In some parts of the State, where the soil is heavy and the growth of pine dense, it is almost impossible to burn the slash in winter. As a matter of fact, this kind of land is bound to be used for agricultural purposes in the near future, and the companies are cutting it as clean as practicable, with a view to selling it to settlers for immediate farming. In this case we require that the slash be burned clean, without any effort to save the young timber. That applies only to certain limited parts of the State, but we think it desirable.

There are all sorts of gradations between the three principal methods of slash disposal—clean burning, piling for burning later, and burning as cutting proceeds by starting fires and throwing the slash on. Often it is very desirable to save the hardwood where pine is being cut and there is a valuable stand of birch, large poplar, and elm. In such cases the cost of slash disposal runs up rather high, but where the companies own the land they are willing to bear the expense, even when it amounts, as in some instances, to a cost of 40 cents a thousand feet. On the other hand, where the operators own only the stumpage it is more difficult to get them to dispose of the slash properly, especially since they are apt to injure the remaining timber and bring about damage suits with the owner of the land.

The character of the trees has an important bearing on slash disposal. For instance, in a thick stand of half-grown white pine, about 14 inches in diameter, there will be a great many limbs and branches. When these are cut the amount of débris is heavy, and it costs at least three times as much to dispose of the slash there as it would in a more open stand of mature white pine.

One of the small things that is really important is the matter of a torch for burning the brush. It has been very difficult to convince the loggers that the torch was a desirable implement. As there is a great deal of birch in that country, they had been in the habit of gathering the bark and starting fires in the piles. They have found, however, that the expense can be reduced considerably by the use of a torch; and they are now having torches made similar to the one used in the Forest Service, consisting of a large pipe designed to contain waste saturated with oil, attached to a smaller pipe, which is used as a handle. The torch should hold about 1½ quarts of oil. It is strong and effective, and saves a great deal of time.

In regard to getting compliance with the law, the larger companies are all right, because the law authorizes the State to go ahead and burn the brush if they do not do it satisfactorily and collect the cost in a civil suit or as a lien on the land. However, with the irresponsible operator who has no property and is liable to be in Minnesota only during the fall and early winter and in Canada in the spring, we find it necessary to adopt somewhat different tactics. These men, as a rule, are contractors, and we reach them by requesting the company from whom they receive the contract to hold back a sufficient amount of their money until the district ranger has certified that the slash is properly disposed of. If they still fail to do the work satisfactorily, the ranger or patrolman may go ahead and do it, using as much of the money that is reserved as the work actually costs. A number of companies have agreed to follow this plan.

One of the reasons why we have got the lumbermen to see this matter of slash disposal in the right light is probably due to the working out of the law in the Minnesota National Forest. The disposal of slash was taken up early by the Federal Government on this Forest, and has worked out very satisfactorily. Conditions have been favorable, the work has been done cheaply, and the results are known to most of the loggers throughout northern Minnesota.

We have more or less difficulty regarding old slash, because the law was not made clear on this point. I believe the law gives us authority to require companies to go back over their cuttings and dispose of old slash. But this would be unfair, and in many cases it would be impossible to locate the responsible parties. Consequently we have interpreted rather broadly that feature of the law and have taken it to mean operations carried on after the passage of the law.

It is a difficult matter to educate a force of men to give uniform instructions regarding slash disposal. Even with our comparatively small number of district rangers, it requires a great deal of careful work and frequent inspection to get them to work in unity. One company may be operating in two or three districts, receiving instructions from as many different rangers. These instructions must be consistent, and they are issued only by the district rangers. A separate notice is issued for each land description, which is handled as a unit. There is a double object in this. The conditions vary in

different parts of the cutting area, but there is also another reason in that, when necessary, we can bring action separately for each notice issued.

In addition to the lopping of slash, the law requires that slash resulting from the construction of roads, trails, and ditches be disposed of. The State itself is doing considerable ditching through the tamarack and spruce swamps; several thousand miles of ditches are being built, some of them veritable canals. Of course, a great deal of débris results from this work. The State, county, and town roads must also be looked after. It is almost as big a task for the rangers to look after road and ditch slash as the logging slash, because it is hard to convince these petty officers that it is their duty to dispose of the débris. The State roads and ditches are, of course, more easily handled.

The whole object of brush burning at present is to reduce the fire risk. We aim, as soon as practicable, to give more attention to the reproduction of forests, but so far as burning and lopping are concerned, protection is still the one idea. While our law has been in operation not quite two years, it has resulted in a broad belt of country being rendered rather safe from fire. Naturally, there are still many areas of old slash, as well as stands of young timber and small reproduction, which are in danger, but we feel that we are gradually bringing about favorable conditions.

DISCUSSION.

Mr. FOSTER. Mr. Cox, have you found it necessary to take to court any case of noncompliance with the law?

Mr. COX. Yes; with the result that the operators disposed of the brush very satisfactorily rather than pay the fine, and at a great deal higher cost than would have been necessary in the first place. Operators may be fined for noncompliance with the law, and they must pay the cost of disposal in addition.

Mr. PETTIS. From what you know of the Adirondacks would you recommend spruce slash burning in our operations?

Mr. COX. No; I think that lopping and the fire line are the proper precautions there, just as in Minnesota. I think the conditions are very similar.

Mr. PETTIS. Why do you have such a wide difference in the cost of slash disposal? Is it due to the time of year?

Mr. COX. Yes; and the men who are doing it. I believe more depends on the men than on anything else.

Mr. PETTIS. Are any of the lumbermen opposed to slash burning?

Mr. COX. Very few.

Mr. PETTIS. One of the chief reasons the Adirondack lumbermen offer for their opposition to top lopping is that it kills reproduction; that is, the actual lopping and the shade from the lopped branches kill the young trees.

Mr. COX. As I already have said, I think one of the reasons why we are able to get the lumbermen to see slash disposal in the right light is because of the successful working out of the law in the Minnesota National Forest.

Mr. RANE. How do they handle the slash on that Forest?

Mr. COX. It is piled and burned, either as the cutting proceeds or very soon after.

Mr. RANE. In your experience do you think burning as the operation is going on is as cheap a method as any?

Mr. COX. It is the cheapest in certain types of forest, especially in our stands of white and Norway pine.

Mr. PETTIS. Have you had any fires escape in places where slash was being burned?

Mr. COX. Yes; quite a number, but we have always extinguished them before they became destructive.

Mr. PETERS. Do you feel that the law needs amending in any important particular?

Mr. COX. In my judgment it does not. I believe there is no important feature lacking in it.

Mr. PETERS. You believe it is a good plan to leave the method of disposing of the slash to the discretion of the forest department?

Mr. COX. Yes. I see no objection to this plan; it has worked out a great deal better than I thought it would. The New York law, as I understand it, makes the lopping of evergreen trees in all cutting operations a hard-and-fast requirement.

Mr. PETTIS. We require lumbermen to lop the branches of evergreen trees in all of the 96 "fire towns." Last year there was some objection to the law, and we started an investigation. We held hearings at three different places; a large number of lumbermen and many others attended. The result is that we are confirmed in the opinion that top lopping is a good thing. We found cases where fires had occurred both in lopped tops and in unlopped tops, and we were thus able to make comparisons. One argument of the lumbermen was, as I already have said, that the lopping and scattering of branches kills reproduction. They also argued that if the tops are not lopped a fire will run underneath them and simply burn the weeds, and that the tops being raised off the ground—on stilts, as it were—will not catch fire. Our investigations scarcely proved this contention. A fire does not run as rapidly in lopped tops as in unlopped tops, and if one starts you are able much more quickly to make a fire line, because the branches are cut off and it is only necessary to separate them.

We have the same trouble which Mr. Cox pointed out in connection with operators who may be working in two or three different counties. Some of our forest rangers may be overzealous, while others are more reasonable. It is a hard job to keep 72 rangers all lined up to see the same thing alike.

The lumbermen make their greatest objection to lopping small trees. This has been a benefit in that fewer small trees have been cut, but I believe that the law will be amended to provide that tops shall be lopped up to approximately 3 inches in diameter, and that it will not be necessary to lop the tops of the smaller trees. Limbs on the part of a tree under 3 inches in diameter will not be more than 2 or 2½ feet long, and they will keep the top raised but a short distance above the ground, which, I think, will not seriously retard the rate of decay. Such a law will, I believe, be sufficient to accomplish the purpose of slash disposal and will save the lumbermen a great deal of money.

The cost, according to the testimony of the lumbermen, varies. If a man is in favor of lopping he will tell you it costs about 25

cents a thousand feet; if opposed, from 60 to 75 cents a thousand. The cost, so far as it depends on the amount of road to be constructed, will be decidedly increased if the roads are on low ground, where there is a large amount of small timber. In some cases, I think, the operators when they build roads through swamps charge too much of the cost to top lopping, for they cut the branches off and use them for road building but charge it to top lopping.

Mr. Cox. In Minnesota we found that the operators figure similarly where they are cutting pulpwood, poles, and posts. They figure the cost of swamping practically all against lopping, although they have to trim the trees anyway in order to get these materials out.

Mr. Pettis. There are two other advantages the operators do not always consider. In the first place, they are removing a great deal of timber they never took before. Now that they have to cut the branch off they frequently take the pulpwood up to 2½ inches in diameter in the top, whereas before it was only taken in some cases to 5 inches. Some of the lumbermen who have watched the operations are willing to admit that the increased amount of material which they take out will offset the increased cost. There are others who contend that lopping the tops reduces the cost of making trails, because when all the tops are cut a log can be skidded anywhere. During the investigation a prominent lumberman, who was making an argument against the top-lopping law, stated that getting the material close to the ground increased the fire danger. He further stated that he was taking pulpwood to about 4 inches at the top end. When asked if the fire danger would be reduced by not taking the pulpwood out to such a small diameter he said that it would, but he could not afford to leave the material in the woods.

FIRE FIGHTING.

The final session of the conference was called to order in the afternoon by C. R. Pettis, superintendent of forests of New York, acting as chairman.

J. E. Barton, State forester of Kentucky, who was unable to be present, sent the following paper on fire fighting:

Gentlemen: With forest fires, as with fires in cities, the essence of successfully fighting and controlling them is a thoroughly trained and dependable organization. To the inexperienced a forest fire is a fearful thing before which men are helpless; this attitude breeds panic, so that effectual work for the control of the fire is out of the question. The experienced man soon learns that forest fires can be classified, have certain more or less fixed phases, and can be successfully fought and controlled. Confidence in these facts, which experience has shown to be true, is nearly half the battle. The means and methods of the actual work of control are largely a product of the immediate exigencies which his calm and experienced judgment suggests. Hysteria in the face of any fire means ineffectiveness. So that in fighting forest fires I feel the necessity in the first place of a well organized and disciplined force wherever possible, or at least it is essential that the men who direct and oversee the work shall have the requisite training and experience.

In the actual fire-fighting operations there is one general principle which suffices, namely, the fire must be reduced to the smallest pos-

sible "front," so that its advance may be eventually checked. This is what the rangers on the National Forests usually call "running the fire to a peak." Generally in coniferous forests this is accomplished by cutting rights of way and digging trenches ahead of the fire, and oftentimes back-firing from the trenches. The trenches are eventually completed around the entire fire, a close patrol maintained to see that the fire does not escape beyond them, and dangerous burning stubs or rotten trees within the fire zone are cut down. In the hardwood region the same general method is employed; but here the fires are ground fires, ordinarily, rather than top fires. Top fires burn more rapidly, so that the work must be planned and carried out far enough in advance of the "front" to give effective results.

In the Northwest there are a few fire-fighting tools which experience has demonstrated are the most satisfactory for general purposes. These are the long-handled shovel, ax, mattock (grub hoe), and crosscut saw. Various other tools have been tried under special local conditions, but these four seem universally most efficient. A short time ago one of the men on the Coeur d'Alene Forest devised a combination ax, mattock, and shovel, and the resulting tool was very satisfactory, according to the latest information I have. The cost of making it was the chief objection. Recently various devices and fire extinguishers have been experimented with, and under certain conditions have proved very efficient. The difficulty with force pumps in many situations is the lack of water, and the same difficulty exists with regard to fire extinguishers where water is one of the chemical agents. In a mountain country the transportation of water and supplies for chemical fire extinguishers is an exceedingly important consideration.

In the eastern hardwood region other instruments and tools are possibly more effective than the ax, mattock, shovel, and crosscut saw. Where leaves and dead foliage serve to feed the fire, rakes and hoes will be found efficient instruments, and water buckets of canvas can be readily used and easily transported. Also force pumps and chemical fire-extinguishing apparatus of various sorts will be more serviceable and effective here than in the West.

The organization, equipment, and maintenance of fire crews in case of large fires is a matter calling for considerable executive ability and ingenuity. Usually small crews of from 8 to 10 men, with a foreman, will be found most satisfactory. It is essential that the fire-fighting force be well organized and systematized and that the commissary be carefully looked after. The commissary, unless well conducted, proves one of the most expensive parts of the whole operation, and careful supervision here usually more than pays for itself.

In Kentucky the fiscal courts of the various counties are authorized to provide funds for fire fighting, but are not compelled to do so. The funds must come largely from the general appropriation for the board of forestry until the system is fairly well grounded in the State. At present there are no cooperative associations of individuals or land and timber owners with funds at their disposal for fire protective purposes, although some firms and corporations have undertaken this work. It is hoped and expected that such associations will be rapidly formed within the State.

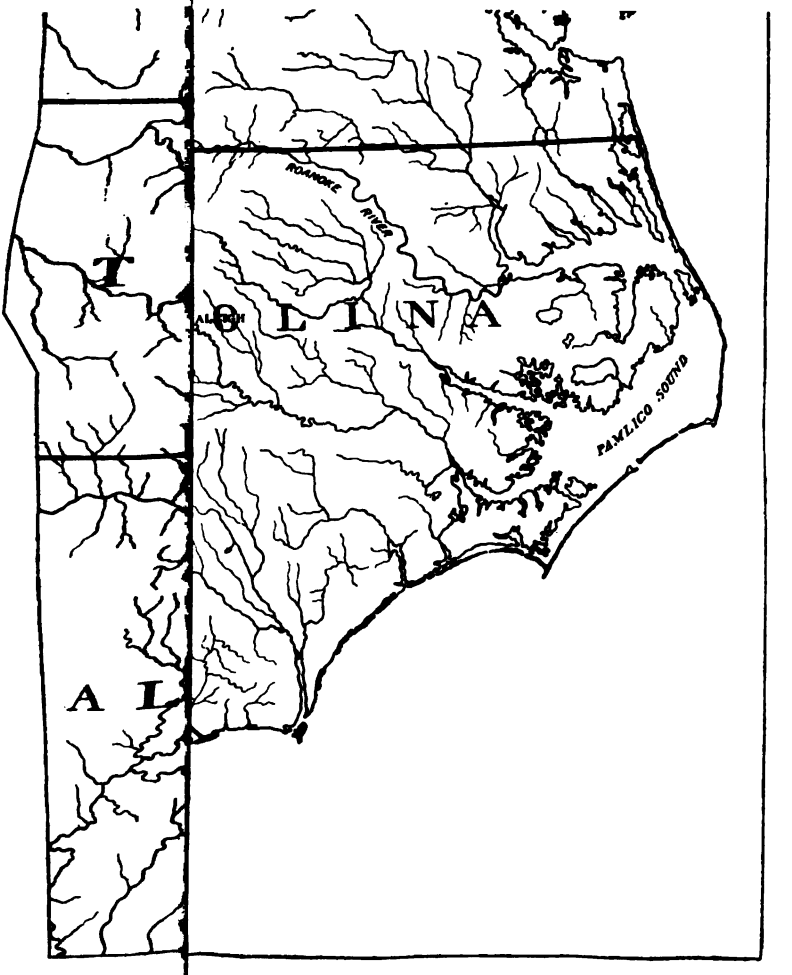
RELATION OF COOPERATIVE FIRE PROTECTION UNDER THE WEEKS LAW TO THE ACQUISITION OF LANDS UNDER THE LAW.

W. L. HALL, assistant forester, Forest Service, gave the following address on this topic:

GENTLEMEN: I assume that all members of this conference are acquainted with the purchase provisions of the Weeks law, so I will take no time to explain them. Purchases have begun both in the White Mountains in New Hampshire and in the Southern Appalachian States. In the White Mountains there is but one purchase area, comprising about 670,000 acres. In the Southern Appalachians we have designated 17 purchase areas, including 5,300,000 acres. On the map (figure 3) you will see outlined the areas in which the Government is now considering purchases in the Southern Appalachians. The reason why these areas were chosen for the beginning of purchases is simply the necessity of restricting purchases to certain localities. We have a limited amount of money with which to buy land. On the 30th of June, 1915, our appropriation will cease as far as it is now made. The money has been made available until expended—that is, $8,000,000 of it—so you see, having a definite sum with which to work, it is necessary to fix certain limits within which we will consider purchases. We are, in fact, not expecting to purchase anything like all of the lands within the areas indicated as purchase areas on the map. The black areas show the lands which have been acquired or are being acquired. It is necessary for us to select those parcels of land which are going to be of the greatest value for the Government to control in the future. Our land must therefore be so grouped in purchasing that we will not, when the money is spent, be left with merely small bodies of land in any one locality; they must be fairly compacted together, so that they can be administered and so that such principles as we wish to apply in handling these forests may be applied.

It is a difficult and delicate question to determine how far we should go in any one locality in buying lands. Our mistake is likely to be, I fear, that we will go too far, scatter our purchases too much, and be left, when our appropriation is ended, with scattered bunches of lands which we will have difficulty in taking care of. We are therefore working against that difficulty all the time, and if we make a mistake it will not be because we have not seen the danger.

As we now view the matter, our best course is to establish bodies of land as well grouped as possible of from 25,000 to 100,000 acres each, and to have these bodies as well distributed as possible over the Southern Appalachian region. The areas indicated on the map as purchase areas merely help us to carry out that part of the program. When we have done that, and while we are doing it, a certain amount of administration is, of course, necessary. We have already acquired and paid for certain lands; they belong to the Government, and under provision which has been made by Congress we can take care also of lands while under contract for purchase; therefore, as soon as a purchase contract is entered into for any body of land that land becomes subject to our protection. The same is true of lands on which condemnation proceedings have been begun.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The land for which the Government assumes responsibility we shall attempt to protect from fire. I suppose we shall not have to ask the States or private timberland owners or their associations to help us in that work. As far as we can see, this work of protection belongs to the Federal Government. It is buying these lands for the purpose of keeping out fires, in part, and naturally it is the duty of the Government, as we see it, as soon as the lands are in our hands to take care of them. We also expect to make improvements on them in the way of roads, trails, telephone lines, and lookout stations.

There is one further thing that may be done: There will always be a lot of private lands adjoining the Government's purchase. It is likely in some cases we may work out cooperative agreements with private owners to place their lands under the Government's jurisdiction, so far as protection is concerned. That is the plan that is being followed upon the National Forests.

Aside from that there is another thing which occurs to me that can be done, although it lies entirely in the future, and that is that the Forest Service ought to encourage as much as possible the organization in the Southern Appalachian Mountains of fire protective associations. In the White Mountains there is such an association, but in the Southern Appalachians there is none, and I believe that the Government should assume some responsibility in encouraging that sort of thing throughout the Southern Appalachian region. With such associations in existence it may be possible for the Government to extend its influence through the associations over a great deal of territory which it can never hope to acquire. I do not believe that the Government can go much further than that.

DISCUSSION.

Mr. Cox. I would like to ask if the areas already purchased are being administered to any extent?

Mr. Hall. Yes; we have attempted to keep out fires.

Mr. Holmes. Mr. Hall, you spoke about timber protective associations in the Southern Appalachians. About a year ago we tried pretty hard to get up a meeting of timberland owners in western North Carolina. I wrote to nearly every owner, but there were only two or three firms that showed any interest at all. I would like to ask how far the Government would encourage an association—whether it would help by protection, or whether it would help in getting up meetings, or things of that sort? Would the Government be able to assist financially an assoeiation extending over the western part of North Carolina?

Mr. Hall. I do not suppose we could arrange to protect private lands, unless under some cooperative agreement whereby the owners and the Federal Government would protect jointly the lands of all parties to the agreement.

With regard to whether such associations can be organized, it seems to me that it is merely a matter of keeping at it. Your first attempt may fail, but if you keep on you are likely to succeed.

Mr. Greeley. I can see no difficulty in carrying out in North Carolina with a landowner the same kind of an arrangement that has been put into effect in Idaho, Montana, and several other States, under

which the Forest Service cooperates directly with timberland associations in the protection of specified localities. There is laid out a fire protective unit, and in which the Government may own 25 per cent of the land and the association may own the other 75 per cent. We join forces with the association in protecting that unit as a whole, because the fire danger there is a common one, and if a fire starts it is just as likely to burn our land as theirs. I can see no reason why the same thing can not be done in the South when the Government has established National Forests there. That would be your position, would it not, Mr. Hall?

Mr. HALL. Yes; entirely.

ADDRESSES BY REPRESENTATIVES OF STATES WHICH ARE PROSPECTIVE COOPERATORS UNDER THE WEEKS LAW.

J. H. FINNEY, chairman of the forestry committee of the Southern Commercial Congress, told of the work of his committee, as follows:

GENTLEMEN: The Southern Commercial Congress, which has its headquarters in Washington, has been doing for the last four or five years a tremendously important work in the way of publicity concerning the resources of the South. It is a movement for a better understanding of the South and its problems. Its slogan is "A greater Nation through a greater South"—a movement that is maintained by voluntary contributions, mainly from people who are concerned in the South's highest and best development.

To further this work the congress has within the past few months increased its activities by organizing various committees, dealing with the most important topics or problems. You can readily see that such committees, composed, as they are, of people in the Southern States, can do more effective work locally and stir up more local interest in the problems than if the work were all done in Washington; but, of course, the work is directed from Washington, and therefore the Southern Commercial Congress keeps in close touch with everything that is being done. Among these committees is the forestry committee, of which I have the honor to be the chairman. This committee is composed of one man in each of the 16 Southern States, and that man has appointed in his State an advisory board of five or more men, so that we have in this way over 100 men and a thoroughly live membership that can work in cooperation with what we outline from this point as the proper sphere of our activity.

We realize that the South is perhaps more indifferent to the forest problem than any other section of the country. While it does not absolutely ignore the existence of the problem, the people are indifferent to it. This is, of course, a severe indictment, but it is practically a true one, or has been until the last two or three years. We believe that this agency of ours is going to be an effective means of getting the Southern States to cooperate not only between themselves but with the National Government for better forest conditions. As I conceive it, the South must have competent State foresters, better laws as regards fire protection, better methods of handling the forests, an equitable system of forest taxation, restriction of cut perhaps, State forest reserves, and anything else that may be with propriety worked for toward the betterment of forest conditions and that will

make for the perpetuation of this tremendously important asset of the South.

Our committee is working to get on the statute books of the Southern States laws which will at least be a step toward ideal forest conditions. Just how to do this work effectively is, of course, a serious problem. We have got the right men in each State, and these men are quite willing to do what we ask of them. I have offered to go to any of the 16 Southern States and talk to the legislature on the forest problems of the State as a business man sees them. I plan to study the local problem intelligently, present it as well as I can, and urge the enactment of laws for remedying conditions that are worse in the South than in any other section of the country. If the legislature invites me to talk they will probably listen to what I have to say, and if an intelligent plan is put up to them for consideration it seems to me that we can, through our local committeeman and his advisory committee in that particular State, bring influence to bear that will help to get the proper laws on the statute books.

We are intensely interested in doing something to remedy the appalling forestry conditions of the South. We will do whatever we can with you or through you or to help you in your work or whatever we can to influence the various legislatures.

J. S. HOLMES, State forester of North Carolina, was next called on. He said:

Mr. CHAIRMAN: North Carolina has so far enacted very little forest legislation. We have made no State appropriation for fire protection, so that we are unable to cooperate with the Department of Agriculture under the Weeks law. I hope, however, that we are going to be able to come in this year.

Our legislature is convening this week, and a bill drawn up by a strong committee of the North Carolina Forestry Association, and backed by that association, will be introduced shortly. This bill will provide for a fire-warden system under the direct control of the State forester, who will be empowered to appoint wardens in townships where they are needed. These wardens will be paid by the State for the time they are actually employed. Other features of the bill require persons to give notice before firing and to watch fires until they are out, railroads to clear off their right of way, and locomotives to use spark arresters.

If we can get this law, or even a part of it, together with a small appropriation—and it will be small—we shall then be able and anxious to cooperate with the Federal Government in fire protection.

Our forestry association has been organized only two years, but we have had two well-attended conventions, showing a large and increasing interest. Our third annual convention will be held next week, and I am looking forward to seeing still more interest manifested.

J. A. VIQUESNEY, forest, game, and fish warden of West Virginia, spoke as follows:

GENTLEMEN: I have endeavored to be a good listener for the past two days. Had I known these speakers were so interesting, I would have tried very hard to induce every member of the legislature of my State, now in session, to come here and listen.

I feel certain there would be no trouble to get proper legislation to qualify under the Weeks law if they properly understood the advantages to be derived therefrom. If I can transmit to them the good impressions I have received from these discussions, I feel certain there will be no trouble in the matter. I am going back to the legislature to do the best I can.

Up until five years ago there had been no effort in West Virginia to control forest fires. Since that time we have been doing all possible under the system we have, and although it is imperfect we have done much good. In the year 1908, from data collected by the Federal Forest Service, there was $3,000,000 damage done to forests in the State by fires. In the last four years this damage has only amounted to a few hundred thousands, and I think enough impression has been made by the little work we have already done to induce the legislature at this session to grant some appropriation whereby we can qualify under the Weeks law.

J. M. GOODLOE, of Virginia, gave the following talk:

GENTLEMEN: There has been practically nothing done in my State toward protection from forest fires. There is no organized effort anywhere in the State that I know of. We have great boundaries of timberland, and fires do considerable damage. I am truly glad that Gov. Mann sent me here to attend this conference, and when I go back home I shall urge him very strongly to give fire protection a great deal of consideration. I believe we ought to be in line with the more progressive States in this movement, and we ought to pass laws that will enable us to secure the cooperation of the Federal Government in fire protection under the Weeks law.

J. B. MOWRY, commissioner of forestry of Rhode Island, followed Mr. Goodloe. He said:

GENTLEMEN: It has been a great help and inspiration to me to attend this conference. I certainly appreciate the spirit with which the Forest Service is cooperating with the States, and I propose to do all I can to make Rhode Island enjoy this cooperation, for which I have already applied at this conference.

We have had a forest-warden system since 1909, and in 1911 a law was passed providing for 10 lookout stations in the State, 2 in each county. The law provides that any two or more adjoining towns, or any two or more private owners, may join in establishing a station, and the State will pay the cost of maintenance. Some of the towns have already appropriated money for the purpose.

We have difficulty in getting this work under way for the reason that in our State the counties cut a small figure politically. We are practically under town government, and when I have suggested that a tower should be built on the highest hill overlooking the county, there has been a tendency on the part of some towns to fail to cooperate. Some of them have said, "This tower is not in our town, and therefore we do not see why we should take any interest in it." However, I think that their attitude in the matter will soon change and that towers will be built in accordance with the law within a short time. I believe we will get one or two towers this spring.

FIRE PROTECTION UNDER THE WEEKS LAW FOR 1913.

The last address of the conference was made by W. B. GREELEY, assistant forester, Forest Service, as follows:

GENTLEMEN: I will attempt only a brief summary of the important considerations which influence the Forest Service in conducting its protective work in cooperation with the States. I will try to give you our point of view on some of the specific aims which the Service is seeking to attain.

It has been stated previously in this conference that the work to be accomplished under section 2 of the Weeks law is primarily educational. Two hundred thousand dollars would not go very far in actual fire protection. Much can be done with that amount, however, in demonstrating in many parts of the country what is possible under systematic fire protection. By the education and encouragement of local interests we can double or triple every dollar of Government money expended. Broadly speaking, for every dollar of public funds expended under this law the expenditure of four or five other dollars has been secured through the stimulus given to the whole protective movement.

Since our purpose is primarily educational, we must restrict closely the extent of our cooperation with any one State. It has been a matter of real regret that we could not increase the allotments to certain States whose effective and clear-cut lines of protective work needed only a little more money to make the system extremely efficient. In deciding such cases we have felt that we must adhere to the broader goal before us; and rather than attempt to develop protection to its maximum efficiency in any one part of the country, stimulate as many different parts of the country as possible to undertake and develop this work.

Mr. Graves said yesterday morning that the appropriation for this purpose was an experiment in a new public policy—assistance by the Federal Government to the States in preserving favorable conditions on the headwaters of navigable streams. We decided at the outset that to make this experiment conclusive it should extend over at least three years. Our fund has been handled with this aim in view. In carrying out this policy it has seemed unavoidable to reduce somewhat the allotments made last year to certain States. Again, we are guided by the same broad principle of helping the more advanced States less that we may enable the new States to make a start. In our allotment for the present calendar year $15,000 has been reserved for new States, which we hope will cooperate with the Forest Service during the coming fire season. We have also reserved $20,000 for emergencies. This little nest egg will be drawn upon to help any State during a critical period like our fire season of 1910.

The Forest Service desires greatly to extend its cooperation to other States. We are particularly anxious to have some of the States in the Southeast enlist in this big national movement. Thus far our cooperation has crossed Mason and Dixon's line only in the case of Maryland. We hope this year to include Kentucky, and are extremely anxious that other Southeastern States, like the Virginias, the Carolinas, and Tennessee, to which the perpetuation of the

lumbering industry is a question of the first importance, qualify for cooperation by meeting the requirements of the Weeks law. The experience of the Forest Service is at the service of any of these States as far as we can aid them in perfecting their protective legislation and field organization. The same applies in equal degree to States in the North, like Rhode Island, Ohio, Michigan, and others which are considering cooperation with the Forest Service.

In this connection I believe that the question of navigability can be made more specific than it was left yesterday morning. We can not accept as navigable streams which serve only for log driving or the transportation of rowboats and skiffs. Any more extensive use, however, such as the transportation of barges or launches of any size, will be considered as establishing the navigability of the stream for our purposes in the administration of this act. Within these limits, our point of view on the question of navigability, as applied to watersheds in new States which desire to cooperate, will be broad and liberal. We will accept as navigable, streams navigated only to the limits of tidewater. I think we may accept short tributaries to the lower courses of large rivers like the Mississippi, which have no important effect upon the flow of water in the main stream but may influence the silting of its channel. I doubt whether we would be justified in the cooperative protection of coastal plains or bottom lands adjoining the lower portions of large streams but not in themselves forming watersheds tributary to such streams. We will, however, be entirely open to conviction on such questions, and we are ready to give the State concerned the benefit of the doubt.

The fact that the adoption of this Federal policy is an experiment makes it essential that its results justify the action taken by Congress and the continuance of the policy which this action embodies. We have therefore felt it necessary to safeguard the expenditure of the funds appropriated under this act with more strict requirements and to exercise closer supervision than might appear necessary. It has not been our purpose to insist upon the adoption of our ideas on the conduct of protective work as against those of the men on the ground who are better acquainted with local conditions. Our aim is simply to make sure that the broader features of this work are maintained at a high standard of efficiency. When the time comes, as it will within a few weeks, for us to report to Congress on the expenditure of this money we must be able to say convincingly that we know that the objects sought in the act have been accomplished. Hence we have laid down certain requirements which may seem to go beyond the reasonable in a certain control of these expenditures. I wish simply to make clear that our object is to make the broad foundations of this work so sure that there will be no question of continuance, as far as they may be determined by the effectiveness of what has thus far been done.

In certain States we have asked that a portion of the allotment be expended for the maintenance of lookout watchmen. Where specific measures of protection have been shown to be particularly efficient, we believe it to be a proper function of the Forest Service to influence the States, and in some instances to require them to adopt such measures. We believe that we should not simply serve as a clearing house for ideas and methods, but that we should make the

best ideas and methods effective by putting them into effect as far as they are locally applicable.

In our requirements as to the number of patrols and of lookout stations in certain States we aim also to establish the foundations for permanent protective systems. It would be a great mistake to allow this work to be stopped if the participation of the Forest Service in it had to be dropped from lack of appropriations. It would be a great mistake to organize it on a temporary basis or to give this whole movement toward conservation in one of its most practical aspects a temporary or spasmodic character. So we have sought, as far as our influence is able, to direct the efforts of the States toward permanent as well as effective protective systems.

We have asked a few States to spend a part of their allotment outside of the area where protective work has hitherto been concentrated. Here again the purpose is to emphasize the educational features of this work. Some of the States, by statutory limitations, are required to spend their funds in certain prescribed portions of the State, leaving the rest of their area without assistance in fire protection. In other States the activity of timber owners has resulted in the effective protection of certain districts, while others are left unprotected. Under these circumstances it has seemed to us a duty of the Federal Government to require such a distribution of this fund as would extend the educational benefit of the work into the parts of States where no protective work is now being made.

Likewise we have asked the States to secure reasonable assistance from the timber owners whose property is benefited and from the railroads, which usually create the single greatest fire risk, as a condition to securing Federal assistance. This requirement also is designed to aid the progress of the State protective work along educational lines as an incentive to greater interest by the private owners of timber or to more effective State legislation.

In all of these things we have aimed to make no requirements which would retard the normal, healthy development of fire protective work in any State. If we have done so in any instance, we will endeavor to be entirely open-minded in adjusting any of these requirements to local conditions and giving the State foresters adequate authority to get the best results without long-range restrictions from Washington.

Your discussions have left little to be said on the cooperative work for the next year. There is one point, however, which I wish to emphasize strongly; that is, more general cooperation on the part of all interests and agencies involved in this big problem. My own experience in fire-protective work in the Northwest indicated that little real progress in the broader features of protective work could be made until we got a great many shoulders at the wheel. The success of the protective work in Idaho and Montana with which I have been particularly familiar has been measured largely by the extent to which we were able to get all interests to pull together. First, the private owners got together and we had protective associations, a tremendous step forward. Secondly, the private owners and the Forest Service got together in the joint protection of lands in and surrounding National Forests. Thirdly, the State was brought into the game in alliance with the private owners or with the Forest

Service, or both. Now in several of the Northwestern States this three-cornered cooperation is working out with varying degrees of efficiency, but in the main getting better every year. A fourth element of almost equal importance was the railroads; and one of the big gains made in protective work in the Northwest was when some of the main railway systems made cooperative arrangements with the Government for joint effort to reduce the fire risk and fire losses along their lines. Much has yet to be done in this region, but the foundations for effective cooperation along all of these lines have been pretty well laid. I feel that the same kind of cooperation must be worked out on all of the large timbered regions before we can get very far in the actual control of the fire problem.

There are, of course, still other elements which must be brought into line. Publicity is essential. You must get at the campers and hunters, at the children in the schools, at the laborers in the logging camps, at the congregations of the churches through their ministers, as Mr. Allen has done. While we may do this specific thing well or that specific thing well and the results are good as far as they go, the really big problem is to get everyone who contributes to the fire risk, directly or indirectly, educated and waked up.

My suggestion is therefore that in all of the States special effort be made to strengthen cooperation with these various elements which should all be helping and whose help, if they all pull together, will be powerful. We believe that the results of these two years justify Congress in making further appropriations for Federal cooperation in this important work. We look forward to continuing this work with you and to making it better and more effective by mutual counsel and advice every year.

APPENDIX.

ROSTER OF ATTENDANCE.

E. T. Allen, Forester, Western Forestry and Conservation Association, Portland, Oreg.
I. W. Bailey, Assistant Professor of Forestry, Harvard School of Forestry, Cambridge, Mass.
H. P. Baker, Dean, New York State College of Forestry, Syracuse, N. Y.
J. F. Baker, Professor of Forestry, Michigan Agricultural College, East Lansing, Mich.
F. W. Besley, State Forester, Baltimore, Md.
J. M. Briscoe, Professor of Forestry, University of Maine, Orono.
R. S. Conklin, Commissioner of Forestry, Harrisburg, Pa.
W. T. Cox, State Forester, St. Paul, Minn.
G. Dawe, Managing Director Southern Commercial Congress, Washington, D. C.
F. A. Elliott, State Forester, Salem, Oreg.
W. O. Filley, State Forester, New Haven, Conn.
J. H. Finney, Chairman Forestry Committee, Southern Commercial Congress, Washington, D. C.
John Foley, Forester, Pennsylvania Railroad Co., Philadelphia, Pa.
J. H. Foster, Professor of Forestry, New Hampshire College, Durham, N. H.
Alfred Gaskill, State Forester, Trenton, N. J.
J. M. Goodloe, Big Stone Gap, Va.
G. A. Gutches, Indian Office, Washington, D. C.
A. F. Hawes, State Forester, Burlington, Vt.
E. C. Hirst, State Forester, Concord, N. H.
J. S. Holmes, State Forester, Chapel Hill, N. C.
M. C. Hutchins, State Fire Warden, Boston, Mass.
Newbold Hutchinson, Georgetown, N. J.
R. C. Jones, Assistant State Forester, Baltimore, Md.
F. F. Moon, Professor of Forest Engineering, New York State College of Forestry, Syracuse, N. Y.
J. B. Mowry, Commissioner of Forestry, Chepachet, R. I.
C. R. Pettis, Superintendent of Forests, Albany, N. Y.
F. W. Rane, State Forester, Boston, Mass.
H. A. Reynolds, Secretary Massachusetts Forestry Association, Boston, Mass.
P. S. Ridsdale, Secretary American Forestry Association, Washington, D. C.
M. C. Rorty, Commercial Engineer, American Telephone & Telegraph Co., New York, N. Y.
E. Secrest, State Forester, Wooster, Ohio.
G. O. Smith, Director U. S. Geological Survey, Washington, D. C., (representative from Kennebec Valley Protective Association of Maine).
E. A. Sterling, Consulting Forester, Philadelphia, Pa.
W. L. Sykes, President Emporium Lumber Co., Buffalo, N. Y.
J. A. Viquesney, Forest, Game, and Fish Warden, Belington, W. Va.
C. P. Wilber, State Fire Warden, Trenton, N. J.
George H. Wirt, Forest Inspector, Pennsylvania Department of Forestry, Harrisburg, Pa.

Representatives from the Forest Service charged with the administration of the Weeks Law.

E. H. Clapp, Forest Inspector.
H. S. Graves, Forester, U. S. Department of Agriculture.
W. B. Greeley, Assistant Forester.
W. L. Hall, Assistant Forester.
L. S. Murphy, Forest Examiner.
J. G. Peters, Chief of State Cooperation.
R. Y. Stuart, Forest Inspector.

In addition to a number of other members of the Forest Service in Washington.

FORM OF FIRE-PROTECTION AGREEMENT.

The form of agreement between the Secretary of Agriculture and the State for the protection from fire of the forested watersheds of navigable streams is as follows:

UNITED STATES DEPARTMENT OF AGRICULTURE.

Agreement for the protection from fire of the forested watersheds of navigable streams under section 2, act of March 1, 1911 (36 Stat., 691).

This agreement, made by and between the Secretary of Agriculture of the United States, under authority of section 2 of the act of Congress approved March 1, 1911 (36 Stat., 691), and the State of _____ by and through its State Forestry Commission, witnesseth:

That whereas the said State has requested the cooperation of the said Secretary in the protection from fire of the forested watersheds of navigable streams; and

Whereas the said State has provided by law for a system of forest-fire protection;

Now, therefore, the said parties do mutually promise and agree with each other as follows:

1. To establish and maintain a cooperative fire-protective system covering any or all private or State forest lands within the State of _____ and situated upon the watersheds of navigable rivers; and to furnish for this purpose Federal and State patrolmen or to take such other protective measures as may be deemed advisable, under the conditions hereinafter provided.

2. The State commission shall furnish maps showing the watersheds and areas which are proposed to be protected under this agreement. The cooperation shall be limited to such watersheds and areas in so far as they shall be approved by the Secretary. The said commission shall indicate the periods during which protection from forest fires is proposed under this agreement; the number of patrolmen, with their stations, which will be employed by the State; the character and extent of other protective measures which it is proposed to put into effect at the expense of the State; and the localities in which it is desired to place Federal patrolmen furnished by the Forest Service.

3. The State forester of _____, acting as an employee of the State commission, shall be appointed collaborator in the Forest Service of the United States Department of Agriculture at a salary of one dollar ($1) a month, and acting in such capacity shall have direct charge of the force of Federal patrolmen employed under this agreement. The State forester shall select the Federal patrolmen, subect to approval by the Secretary, instruct them *in writing* as to their duties, supervise their work, and certify to their services on pay rolls of the Forest Service.

4. The Federal patrolmen so selected shall be appointed as temporary laborers in the Forest Service at a per diem rate not exceeding _____ dollars ($____); provided that they shall be employed exclusively in the protection of areas on the watersheds of navigable rivers which shall have been approved by the said Secretary.

5. This agreement contemplates the employment under ordinary conditions of fire hazard of not to exceed _____ Federal patrolmen, or in case of emergency of not to exceed _____ Federal patrolmen in the discretion of the collaborator, provided that in case of serious emergency the latter number may be increased with the approval of the Forester.

6. The State commission shall secure for the Federal patrolmen furnished under this agreement, by appointment as deputy State fire wardens or otherwise, without additional compensation, such police powers for the prevention and control of forest fires as may be granted under the laws of the State of _____, and shall equip such Federal patrolmen with such fire-fighting tools or devices and shall authorize them to employ such assistance in fighting fires as its funds and the State fire laws and regulations will permit.

7. The total sum to be expended by the Federal Government durinp any calendar year for the purposes of this agreement may equal but shall not exceed _____ dollars ($____); but in no case shall the amount expended by the Federal Government in any Federal fiscal year exceed the amount appropriated by the said State for and expended by it during the same period for the purpose of protecting from fire forested watersheds of navigable streams in

said State. This agreement contemplates an expenditure of State funds of at least _____ dollars ($____); and in the event of such expenditure falling below said amount the Federal expenditure will be decreased proportionately.

8. Payment for the services of Federal patrolmen employed under this agreement shall be made at the end of each calendar or fractional month on vouchers certified by the State forester as collaborator, and forwarded to the Forester, Forest Service, Washington, D. C., provided that no patrolman will be employed except during the real danger season from forest fires on the watersheds and areas approved by the Secretary under this agreement.

9. The said Secretary and his authorized representative shall have full authority to inspect the protective areas and the force herein authorized, and at his option, by giving the State commission written notice, may withdraw his approval of any such area or portion thereof, or terminate the employment of any Federal patrolman or patrolmen or of the State forester as collaborator in the Fest Service.

10. The State forester shall be responsible for seeing that each patrolman keeps a vigilant lookout for forest fires in or threatening his district, and that he makes every possible effort to extinguish such fires as occur, whether they are on lands belonging to the State, the Federal Government, or a private owner, provided that during the patrol period when in the judgment of the State forester patrol is unnecessary the patrolmen may be used on other fire-protection work. The State forester or his representative shall from time to time make such personal inspection of the cooperative fire-protection work done under this agreement as may be necessary to promote the effectiveness of said work.

11. The said State forester shall, with respect to all private forest land afforded protection against fire under this agreement, use every proper means to bring about the active cooperation of the owner in such protection, including aid from him in the form of hire of one or more patrolmen, construction of permanent improvements, and the like.

12. Both the State commission and the Forest Service of the United States Department of Agriculture shall have equal right to publish the results of the cooperation under this agreement: *Provided*, That any results intended for publication, except press notices of momentary or local interest, be approved by the commission and by the Secretary. In all such publications it shall be plainly stated that the results were secured through cooperation between the commission and the Secretary.

13. This agreement shall become effective on the _____ day of _____, 191__, and shall continue in force thereafter, subject, nevertheless, to the availability of funds appropriated by Congress by the act of March 1, 1911, for the purposes herein mentioned, and to any amendments which may be made hereof by mutual agreement of the parties; and it is expressly understood that this agreement or any modifications hereof may be terminated by either party upon thirty (30) days' written notice to the other.

In witness whereof the said commission has hereunto caused its name and seal to be affixed by its proper officers, on the _____ day of _____, 191__, and the said Secretary has hereunto set his hand and affixed his official seal on the date below written.

_____ _____,
President State Forestry Commission.

_____ _____,
Secretary of Agriculture.

Signed and sealed by the Sercetary of Agriculture this ___ day of _____, 191__.

RURAL MAIL PATROL ORDER.

POST OFFICE DEPARTMENT,
FOURTH ASSISTANT POSTMASTER GENERAL,
DIVISION OF RURAL MAILS,
Washington, June 8, 1912.

To the POSTMASTER.

SIR: Your attention is directed to the following order issued by the Postmaster General under date of May 31, 1912:

"ORDER No. 6315.

"The following instructions are promulgated for the guidance of the postal employees concerned:

"In accordance with the request of the Secretary of Agriculture, this department has arranged a plan of cooperation with State and National forest officers whereby rural and star-route carriers shall report forest fires discovered by them along their routes to persons designated by the State and National authorities to receive such intelligence.

"Cooperation with State officers will be given in the following States: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Maryland, West Virginia, Tennessee, Kentucky Michigan, Wisconsin, Minnesota, Idaho, Washington, Oregon, and California.

"The national forest officers will be cooperated with in the following States: Florida, Arkansas, South Dakota, Wyoming, Colorado, New Mexico, Arizona, Utah, Montana, Idaho, Washington, Oregon, and California.

"The State and National authorities will inform postmasters as to whom the discovery of fires should be reported, and each rural carrier should be directed to cooperate to the fullest extent with such authorities in the manner agreed upon, namely, that the carrier shall report a fire to the nearest State fire warden or National forest officer on his route, or, if no such warden or officer lives on the route, to arrange through some responsible citizen to have him notified, by telephone, if possible. Star-route contractors and carriers are included in the plan of cooperation and should be requested to report the discovery of fires in the same manner as will be done by the rural carriers.

"Postmasters in or near national forests are also directed to report fires to the nearest forest officer."

Respectfully,

P. V. DE GRAW,
Fourth Assistant Postmaster General.

FORM OF TELEPHONE AGREEMENT.

The form of agreement between the Secretary of Agriculture and the associated telephone companies of the American Telephone & Telegraph Co. is as follows:

This agreement, made this ------ day of ------, 19--, by and between ----------, a corporation organized and existing under and by virtue of the laws of the State of ------ (hereinafter called the "Telephone Company"), of the first part and the SECRETARY OF AGRICULTURE OF THE UNITED STATES (hereinafter called the "Secretary") of the second part,

WITNESSETH:

Whereas the Telephone Company operates a general public commercial telephone exchange and toll-line system, which includes certain exchanges and toll lines located in the neighborhood of certain National Forests under the jurisdiction of the Secretary and situated in whole or in part in the territory of the Telephone Company; and

Whereas the Secretary desires to utilize, as an aid to the administration, protection, and preservation of said National Forests and in fire prevention and control, certain special telephone facilities which the Telephone Company is able to supply, and the Secretary also desires to procure from the Telephone Company, in connection with fire prevention and control and in the administration of said National Forests, telephone exchange and toll-line service; and

Whereas the Telephone Company is willing to furnish for the foregoing purposes the special telephone facilities and the telephone exchange and toll-line service hereinafter mentioned, and is also willing, to the extent and in the manner hereinafter set forth, to cooperate with the Secretary and to enlist as well, so far as possible, the cooperation of the Telephone Company's subscribers in the vicinity of said National Forests, in facilitating and supplementing the operations of the Secretary in fire prevention and control:

Now, therefore, in consideration of the premises and of the covenants and agreements hereinafter set forth, it is agreed by the parties hereto as follows:

ARTICLE I. The Telephone Company will, as the Secretary may during the continuance of this agreement from time to time request—

1. Connect, by telephone line or lines of suitable type, with the central office of the Telephone Company in any exchange then established in any municipality

or settlement adjacent to or in the neighborhood of any National Forest telephone stations in such number, on any one such line, and at such locations, within or adjacent to said National Forests and outside the limits of such an exchange, as the Department of Agriculture may require; equip each such line at the terminal thereof in such an exchange with such of the Telephone Company's standard terminal apparatus as will reduce to a practical minimum the chances of central-office trouble interfering with the operation of such a line; and furnish thereover local exchange, local toll, and long-distance telephone service under the terms and conditions and at the rates set forth in the annexed schedule marked "A"[1] and hereby made a part hereof; provided, that the Department of Agriculture will, at its own expense, equip, install, and maintain, as herein provided, each of such telephone stations, and furnish and maintain, as herein provided, that portion of each such line which may extend to and between such stations and a point, to be designated by the Telephone Company, ordinarily at or near the central office of the exchange with which each such line may be connected or, in case of an exchange operated within a municipality, at or near the limits thereof, the Telephone Company to furnish and maintain that portion of each such line which may extend to and between said junction and the switchboard of the Telephone Company's said central office.

2. Furnish, for use by the Department of Agriculture in equipping any of the foregoing telephone stations, sets of telephones, with the necessary station equipment, appropriate for use hereunder and of any standard types then furnished by the Telephone Company to its subscribers and lessees in the exchange serving any such telephone station, each such set to be furnished upon the terms and conditions and at the annual rental specified in the annexed Schedule "A."

3. Furnish to the Secretary, in addition to the class of service hereinabove described in section 1, in any public telephone exchange then operated by the Telephone Company, such of the Telephone Company's regular classes of exchange and toll-line service, and such other service regularly furnished by it to the public as such exchange may supply and under the terms and conditions and at the rates expressed in said Schedule "A.".

4. Furnish without charge, for the attachment of any telephone circuit furnished and maintained hereunder by the Department of Agriculture, space on any of the Telephone Company's pole lines located within any National Forest contemplated hereby or extending therefrom to the nearest exchange of the Telephone Company, or, in case such an exchange is located in a municipality, then to a point, to be designated by the Telephone Company, at or near the limits of such municipality; provided, that any such attachments to the Telephone Company's pole lines shall in all cases be made under its supervision and direction and in accordance with its standard specifications and engineering practices, and then only whenever, in the judgment of the Telephone Company, spare facilities for such attachments exist.

5. Construct for the Department of Agriculture in, through, and adjacent to any National Forest contemplated hereby such telephone pole lines as said department may require for use hereunder, string telephone circuits thereon, install the necessary telephone-station equipment to be used in connection with such circuits, keep such pole lines, circuits, and station equipment in repair, and in cases of emergency sell to the Department of Agriculture such telephone equipment and line material and supplies as can reasonably be spared from local stock rooms of the Telephone Company. All of the foregoing services to be performed by the Telephone Company for the Department of Agriculture at actual cost, including reasonable and proper charges for supervision plus ten per cent (10%), and all of the foregoing sales to be made at actual cost at

[1] Schedule "A" must be negotiated with each local telephone company within whose territory the Secretary desires telephone service on the basis of those concessions which each party to the agreement is actually able to make within the territorial limits of such local company. Thus, Schedule "A" may modify the main terms of the agreement to any extent and in any particular necessary to adjust them to local conditions.

State foresters particularly should bear this clearly in mind, since only where the State has valuable concessions to make to the local company can it be expected that equally valuable concessions in the form of reduced rates and the like will be granted by the company.

point of delivery plus ten per cent (10%); provided, that the Telephone Company shall not be bound hereunder to begin the construction of any line requested by the Department of Agriculture until the expiration of a reasonable time after the receipt by the Telephone Company of such request, which shall not be less than the time usually taken by the Telephone Company in preparing for the construction of its own lines.

6. Permit the Department of Agriculture, without charge and at its own expense, to attach to and maintain on the Telephone Company's poles, at such reasonable lookout points as may be agreed upon by the respective representatives of the parties hereto, designated as hereinafter provided, lock boxes equipped with sets of telephones, and to connect such sets of telephones directly with the Telephone Company's circuits attached to such poles, with the right to the Department of Agriculture to use such sets of telephones, in cases of emergency only, for telephonic communications over such circuits; and the Telephone Company will also, in such cases, allow the Department of Agriculture to connect its portable emergency sets of telephones, for like purposes, with the Telephone Company's circuits located within or adjacent to any National Forest contemplated hereby; provided, that the right herein granted to connect such lock box telephone sets with such circuits may be refused by the Telephone Company when such connection would involve the use hereunder of a toll circuit connecting together any two public telephone exchanges, and that connections of lock box telephone sets shall be made hereunder with subscribers' circuits only after any necessary consents of other users of such circuits have been obtained. The Department of Agriculture hereby agrees that any connections of emergency telephone sets with the circuits of the Telephone Company hereunder, shall be made by the Department of Agriculture upon its own responsibility, and said department shall hold itself liable to the subscribers and patrons of the Telephone Company for any claims of loss, damage or injury resulting from such connections.

7. Designate local officials or employees to cooperate with the officials or employees of the Department of Agriculture in the work of constructing, equipping, and maintaining any telephone pole lines and circuits, and in the work of installing and maintaining any telephone station equipment, which the Department of Agriculture may undertake to provide and maintain hereunder; furnish engineering and other advice and information, together with plans, drawings, blue prints, specifications, and recommendations with reference thereto; actively cooperate with such officials or employees of the Department of Agriculture in providing emergency communication by telephone during forest fires; and in behalf of and as agents of the Department of Agriculture in securing the prompt delivery of any telegrams transmitted by telephone during such fires to or for any employee of the Department of Agriculture.

8. Keep open at any or all hours, under special conditions of emergency or public necessity, in any exchanges contemplated hereby, such of the Telephone Company's central offices not regularly open at all hours, as may at such time be designated by the Department of Agriculture, such special service to be performed by the Telephone Company for the Department of Agriculture at the actual cost thereof in each case.

9. Allow any employee of the Department of Agriculture to charge, to any of its telephone stations served hereunder by an exchange of the Telephone Company, any message which such employee may transmit from any lock box or portable emergency telephone set herein provided for, or from the telephone station of any subscriber of the Telephone Company, provided, that if the telephone station accepting such a charge is not the station called, it shall be a station connected with the exchange at which the call originates.

10. Require its employees to strictly observe all the rules and regulations of the Department of Agriculture relating to the care and protection of the National Forests; exercise due care and caution to avoid injury to growing timber; and give prompt notice to the Department of Agriculture of any forest fires discovered by them, or of which they may receive notice, when engaged in any work in said forests.

11. Use its good offices in arranging, so far as possible, with its subscribers in or near any National Forest to give prompt notice to the Telephone Company's central office directly serving such subscribers of any forest fires discovered by such subscribers or of which they may receive notice, and instruct its operators and other employees promptly to communicate such notice to the local forest officials.

12. Furnish to the Department of Agriculture maps showing the arrangement and location of the circuits, pole lines, and exchanges of the Telephone Company in the neighborhood of any National Forest contemplated hereby.

13. Use its good offices to secure for the Department of Agriculture, upon terms and conditions substantially similar to those herein provided for, suitable arrangements for the furnishing of service similar to the service herein provided for, by such of the connecting companies of the Telephone Company within its territory as the Department of Agriculture may in each case desire or approve.

14. Extend the telephone facilities and service covered by this agreement to State authorities and private timberland owners cooperating with the Department of Agriculture in forest protection in so far as, in the judgment of the Telephone Company, such facilities and service may reasonably be so extended; provided, that any special rates for exchange or toll-line service set forth in the annexed Schedule "A" shall in no case be allowed hereunder to such State authorities and timberland owners for any purposes other than forest protection.

ARTICLE II.[1] The Secretary will:

1. Upon request, from time to time, when compatible with the public interest, grant or cause to be granted to the Telephone Company, its successors and assigns, easements for rights of way for periods of fifty (50) years from the date of the issuance of such grants for the construction, operation, and maintenance of any telephone lines which the company may have constructed, or may in future desire to construct, over, across, and upon any of the National Forests of the United States, or any land under the jurisdiction of the Department of Agriculture, including the right to cut down or trim any trees which may interfere with or endanger such lines; provided, that the grant of such easements to the Telephone Company, under the act of March 4, 1911 (36 Stat., 1235), shall be subject to general regulations issued thereunder by the Secretary of Agriculture in force at the time such grants are made.

2. Permit the Telephone Company, without charge, to attach the telephone circuits of its general commercial telephone system to the pole lines of the Department of Agriculture, now or hereafter located within any National Forest contemplated hereby or extending from such National Forest to, or to points near any public telephone exchange of the Telephone Company; provided, that such attachments shall be made in accordance with the rules and regulations of the Department of Agriculture, and shall be permitted only when and where, in the judgment of the Department of Agriculture, spare facilities exist.

3. Sell to the Telephone Company, in accordance with the regulations of the Department of Agriculture, for the construction and maintenance of the latter's lines, either within or outside of the National Forests, timber from such of the National Forests as are traversed by or are adjacent to such lines.

4. Use or require to be used upon all telephone circuits furnished and maintaned by the Department of Agriculture for use hereunder, in connection with the exchanges and lines of the Telephone Company, only such telephone transmitters, receivers, apparatus, appliances, equipment, and material as shall in all cases be of a standard approved by the Telephone Company as suitable for the purposes of this agreement.

5. Equip at all times with such protective devices, and keep in such repair and maintain in such a manner as shall conform to the standard requirements of the Telephone Company for the performance of such work by its employees, all telephone transmitters, receivers, apparatus, appliances, equipment, material, wires, and circuits maintained by the Department of Agriculture and used hereunder directly or indirectly in connection with the exchanges and lines of the Telephone Company.

6. Protect, in accordance with the standard specifications and engineering practices of the Telephone Company, from all danger of or exposure to crosses or contact with or induction from high tension electrical circuits, all telephone circuits maintained by the Department of Agriculture and used hereunder in connection with the exchanges and lines of the Telephone Company or attached to its poles.

7. Observe, in the use of the telephone stations and circuits furnished or used hereunder in connection with the exchanges and lines of the Telephone Com-

[1] Since the form of agreement was perfected Congress has given the Secretary of Agriculture authority to grant free poles to telephone companies whenever he may deem it necessary for the protection of the National Forests.

pany, all reasonable rules and regulations of the Telephone Company governing the use of its subscribers' stations and not inconsistent with the provisions of this agreement.

8. Permit to the Telephone Company, at all reasonable times, access to any telephone station equipment or telephone circuit, used hereunder in connection with the exchanges or lines of the Telephone Company, for making such inspections or such service tests as may be requisite for the purposes of this agreement.

9. Pay, in accordance with the terms and conditions, and at the rates set forth in the annexed Schedule "A," all charges for local exchange, local toll, and long-distance telephone service furnished hereunder by the Telephone Company, and also pay, in accordance with the provisions hereof, all other charges of the Telephone Company for any other services performed hereunder, or for instruments, equipment, material, and supplies furnished to the Department of Agriculture by the Telephone Company.

10. Designate officials and employees with authority to assist and cooperate with the designated officials and employees of the Telephone Company in the construction and maintenance of the telephone lines furnished and maintained hereunder by the Department of Agriculture, and in generally effectuating the provisions of this agreement; and with the further authority to requisition or obtain, in behalf of the Department of Agriculture, any telephone circuits, apparatus, appliances, equipment, and material for use in emergencies, the construction, maintenance, or repair of telephone lines used hereunder, or any benefit or thing accruing to or to be derived by the Department of Agriculture under or by virtue of the provisions of this agreement.

ARTICLE III. It is expressly understood and agreed between the parties hereto that:

1. This agreement does not contemplate the use hereunder, in connection with any regular service of the Telephone Company, of any telephones and station equipment not furnished by it, except in cases of emergency, and the use of any such telephones and equipment is so permitted only in view of the public demand and necessity therefor.

2. No part of the facilities and service furnished hereunder by the Telephone Company to the Department of Agriculture shall be used in connection with any service for which a charge or compensation shall be received or collected by the Department of Agriculture from any person, firm, or corporation without the express approval and consent in writing of the Telephone Company.

3. No telephone transmitter, receiver, apparatus, wire, or circuit furnished to or used hereunder by the Department of Agriculture in connection with the exchanges and lines of the Telephone Company shall in any case, without its express approval and consent in writing, be connected directly or indirectly with any telephone transmitter, receiver, apparatus, wire, circuit, or service other than that of the Telephone Company, nor shall any telephone station served hereunder by an exchange of the Telephone Company be located outside its territory without such approval and consent.

4. Upon the termination of this agreement as hereinafter provided all connections of the telephone circuits furnished and maintained by the Department of Agriculture, theretofore made with the general commercial telephone system of the Telephone Company, may be discontinued and severed by either party hereto, but if at the termination of this agreement either party shall desire to continue the attachments made hereunder to the pole lines of the other, such attachments shall be allowed to remain on such poles under such terms and for such rental charges as may be agreed upon between the parties. In the event that the parties hereto are unable to agree as to the terms or rental charges for attachments other than those covered by specific easements, which may be retained on said poles, as above provided, all questions at issue between them shall be submitted to a board of arbitration composed of three members, one to be selected by each party and the third to be chosen by the two thus selected, and the finding of the majority of such board shall be final and binding upon both parties.

5. The provisions of this agreement shall be binding upon and shall accrue to the benefit of the successors and assigns of the Telephone Company.

6. No Member of or Delegate to Congress is or shall be admitted to any share or part in this agreement or to any benefit to arise therefrom. (Sections 3739–3741, United States Revised Statutes.)

This agreement shall remain in force for a period of one year from the date hereof, and thereafter shall be automatically renewed for periods of one year unless canceled by written notice from either party to the other not less than sixty (60) days prior to the expiration of any one-year term.

In witness whereof the parties hereto have caused this instrument to be executed in duplicate the day and year first above written.

_____,

By _____.

Attest:

_____, *Secretary.*

_____,

Secretary of Agriculture.

ADDITIONAL COPIES of this publication may be procured from the SUPERINTENDENT OF DOCUMENTS, Government Printing Office, Washington, D. C., at 10 cents per copy.

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L. Howard.

GRAZING IN THE FOREST RESERVES.

BY

FILIBERT ROTH,

Chief of the Forestry Division of the General Land Office, Department of the Interior.

[REPRINT FROM YEARBOOK OF DEPARTMENT OF AGRICULTURE FOR 1901.]

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GRAZING IN THE FOREST RESERVES.

By FILIBERT ROTH,
Chief of the Forestry Division of the General Land Office, Department of the Interior.

INTRODUCTION.

In a consideration of the grazing problem in the forest reserves of the United States, it is necessary at every step to keep in mind the objects for which the reserves were set aside and the character, as well as the behavior, of the woods which exist on these several reserves. Since there appears to be still a great deal of confusion concerning the motives and objects which led to the formation of reserves, and also as to the character and behavior of forests in general, and the woods of the several reserves in particular, it may be helpful to review some of these points more in detail.

GENERAL DISCUSSION OF THE FUNCTIONS OF FORESTS.

When a farmer in Ohio or Indiana has a piece of woods on fairly level ground he has no good reason for keeping it as woods unless he considers the wood growing on the land to be as valuable as any other crop he might raise—a matter often difficult to decide. A farmer in Mississippi, on the other hand, may be induced to leave a patch of forest on a hillside, not because he cares much for the wood, but because, if the forest is cut away, the land will wash into a labyrinth of deep gullies and soon become utterly worthless for any purpose. In the former case the forest is merely for the crop it yields; in the latter it is for both crop and protection, and this case is far more common than is usually supposed. But while the farmer in Mississippi may use the forest to keep a piece of land from gullying, and thus use it as a protection against erosion, he cares little as to how this forest affects the flow of water or the climate, for he has ample rain and does not utilize the creek or stream. With the farmer in Gallatin Valley, Montana, this is quite different. He takes what seems to be a desert gravel bar and by the use of 1 inch of water per acre[1] he converts this arid ground into a farm and raises as high as 90 bushels of a superior quality of oats per acre. To him the little mountain stream is everything. Here the forest takes on another function; it holds the soil of the neighboring mountains and keeps it more pervious, and thus it regulates the flow in these important streams. The manner in which it does this will be clearer from the following: Suppose we take a table

[1] The inch of water here referred to is a miners' inch. Fifty miners' inches require a stream furnishing 1 cubic foot per second.

and tilt it several inches, so that its top represents a slanting surface. If we sprinkle water on this surface, it is clear that the water runs off about as fast as it strikes the table. If the table is now covered with a layer of soil about 3 inches thick, and the sprinkling is renewed, some of the water runs off from the surface and some soaks into the layer of soil, so that if, after a time, we quit sprinkling there will still be water running off from the table for hours. We have here then a "surface run-off" and an "underground run-off," and it is clear that the thicker the layer of earth, and the more pervious, the more water it would take up and the longer and steadier it would be giving off this underground water.

The above statement shows exactly what happens all over the land, and is especially noticeable in the mountains. On the soilless, rocky slopes the water runs off as fast as it falls or the snow melts, but on slopes with deep, pervious soils part of the water is stored and continues to flow for months after the rain or the melting of snow has ceased.

Returning to the experiment with the layer of earth on the table, we notice that if we sprinkle more briskly, part of the earth is carried away, the layer is eroded, and the storage ground is diminished. If covered by a layer of cotton batting this erosion stops, and in addition we gain another very important point—the soil is kept softer, and allows water to soak in more easily than when the cotton is wanting, for then the water "pats" down; it hardens the surface where it does not wash it away. Much the same result might be obtained by sowing grass on the layer of earth, for then the tops of the grass would keep the drops from pounding the earth, form a mechanical obstacle to the surface run-off, and the roots would be an additional help in holding the earth and keeping it from washing away. But the grass is small, its tops are short, open, and close to the ground; its roots are short; it rarely forms a dense sod, and, especially in dry countries, it leaves a large part of the ground without protection. Here, then, the larger, long-lived, deep-rooted trees, with dense, shading crowns high above the ground, give far better and more constant protection against erosion, and are far better able to keep the ground in a pervious condition, since they strew it annually with large quantities of leaves and twigs and provide a network of slowly decaying roots which keep the forest soil mellowed for a foot and more in depth. An upturned hemlock, spruce, etc., will readily illustrate how much of the ground is occupied by the roots of these forest trees.

The trees, then, are in nature what the cotton is in the experiment; they help to keep the soil from being carried away, they keep it soft, and they break the force of the downpouring rain.

How much additional service trees perform by keeping sun and wind from the ground is well illustrated by the forests of the Lake States and Canada, where thousands of swamps have dried up and hundreds

of miles of corduroy road have become useless, not by ditching and draining, but by removing the woods and giving sun and wind access to the soil.

In this connection, it may be well to mention a theory, sometimes advocated, which teaches that it would be better for water-storage purposes to have the forests removed in order that the snow may gather in large drifts, since, as it is claimed, it is these snowdrifts which supply the water of the streams throughout the dry summer season. This is not borne out by facts, for a study of the Big Horn Mountains and the Rockies of Wyoming, Montana, or Idaho will convince anyone that the few lingering snowdrifts of August have very little to do with the streams, and that it is the wooded and not the bald districts of each basin which serve as feeders and maintain the steady flow of water. The allied claim that snow melts more quickly in the forest than in the open is so palpably inconsistent with actual experience and simple physics that one might as well claim that the construction of an ice house to cover the season's supply was unnecessary, since ice would last longer in the sun than under cover.

Though there exist numerous forests in this country where the protective function of the woods is not apparent, in the majority of cases, and in all mountain districts without exception, the forest serves both to supply useful material and to protect and improve the ground, and thereby regulate the surface and underground drainage.

THE OBJECT OF THE RESERVES AND THE CHARACTER OF THEIR FORESTS.

For the forests of the present reserves it may be said that the protective function has been regarded as the more important. It is evident, therefore, that efforts will be made to maintain and improve these woods in order to continue to increase their usefulness in furnishing material, and still more in performing their protective function. This is the object of the forest reserves. The main purpose of the reserves is not exclusion, as is still so often claimed. They merely provide the means and men to give the much-needed care and protection which private enterprise at present could not afford and probably would be unwilling to furnish for a long time to come.

Scattered over a wide range of country, from the British line to Mexico, with climates varying from cold to hot, from excessively wet to arid, in altitudes of from 1,500 to 11,000 feet, the forests of the several reserves differ widely. In the Black Hills a fine forest of Yellow Pine covers a broad expanse of high, rolling ground and hills, and serves chiefly as a valuable source of timber. In the Western Rainier a dense forest of fine conifers on steep alpine ridges keeps the waters from carving the mountains into a waste. In the Big Horn a growth of pole-size Lodgepole Pine occupies a rough plateau, ranging

from 8,000 to 9,000 feet in altitude, and helps to keep the useful streams from going dry.

Similarly, these woods differ in their present condition. The valley of the Skagit in the Washington Reserve is almost an unbroken burn, and large burned-over areas, known as "burns," are scattered over the majority of the ridges of the east side of this same reserve. Similar conditions are met in the Mount Rainier, the Big Horn, the Priest River, and other reserves. In some cases these old burns have become reclothed with young forest trees, in others they are thickets of brush (species not trees), and in others they have changed to grassy pastures, often with little prospect of restocking under the conditions now prevailing. In some cases, as in the Big Horn Reserve, part of the extensive old burns are now so unmistakably prairie that it is difficult to prove that they were ever woods. Generally, however, a search reveals some fragments of stumps, bits of charcoal, etc., which show that at some time, at least, these places were not altogether prairie, and that a return to a wooded condition may be looked for. Besides these parks or grassy openings and small prairies (probably all due to fire), which in the aggregate cover many thousands of acres, there are large tracts of forest, such as the Yellow Pine woods of the Black Hills, where the mature timber, in keeping with the habits of this kind of pine, no longer forms dense stands. Here the ground is but little shaded, and a vigorous growth of grass and weeds eagerly seizes upon every yard of available soil, and thereby often prevents the starting of tree growth. (Pl. XXXII.)

In other districts, where high altitudes tend to give an alpine character to the land, tree growth naturally becomes more scrubby and broken, and, in regions like the Cascades, at the tops of the high ridges are grassy parks, covering many thousands of acres more or less interrupted by patches of scrub woods. Whether these grassy areas were ever entirely clothed with woods, and whether, with any reasonable amount of care or protection, they can be made to reclothe themselves, is still in some cases uncertain.

In general, then, the forests of the reserves are primarily protective forests, they differ from reserve to reserve, they are all more or less damaged by fires, and in all dry localities and at high altitudes they are interrupted by grassy areas, the majority of which have long been in their present condition, and will probably require a long period of time before they are restocked with woods. (Pls. XXXIII and XXXIV.)

REGULATIONS FOR GRAZING IN THE RESERVES.

When the several reserves now in existence were created, the majority of them included districts which had been used for some time for grazing purposes, and the attempt to stop further grazing affected interests of considerable magnitude.

FIG. 1.—AN OLD BURN AS SHEEP RANGE. MOUNT RAINIER RESERVE.

FIG. 2.—SHEEP IN OPEN-PARK WOODS OF YELLOW PINE. BLACK MESA RESERVE.

FIG. 1.—OLD BURN WITH DENSE GROWTH OF YOUNG PINE ("TOO MUCH BRUSH"), NOT USED AS RANGE. WASHINGTON RESERVE.

FIG. 2.—OLD BURN IN THE ALPINE REGION OF THE CASCADES (LITTLE REPRODUCTION AND POOR FEED). WASHINGTON RESERVE.

FIG. 1.—ALPINE PARK WOODS NEAR COWLITZ PASS, ON THE CREST OF THE CASCADES. MOUNT RAINIER RESERVE.

FIG. 2.—A SITUATION WHERE THE GROUND NEEDS ALL THE COVER IT HAS. BLACK MESA RESERVE.

PRESENT RULES FOR GRAZING IN THE RESERVES.

At present, the following ruling of the General Land Office, based on the law approved June 4, 1897, and published in a circular, "Rules and regulations governing forest reserves," November 6, 1900, govern in all affairs of grazing within the reserves:

PASTURING OF LIVE STOCK.—The pasturing of sheep and goats on the public lands in the forest reservations is prohibited: *Provided*, That in the States of Oregon and Washington, where the continuous moisture and abundant rainfall of the Cascade and Pacific Coast ranges make rapid renewal of herbage and undergrowth possible, the Commissioner of the General Land Office may, with the approval of the Secretary of the Interior, allow the limited grazing of sheep within the reserves, or parts of reserves, within said States. *And also provided*, That when it shall appear that the limited pasturage of sheep and goats in a reserve, or part of a reserve, in any State or Territory will not work an injury to the reserve, that the protection and improvement of the forests for the purpose of insuring a permanent supply of timber and the conditions favorable to a continuous waterflow, and the water supply of the people will not be adversely affected by the presence of sheep and goats within the reserve, the Commissioner of the General Land Office may, with the approval of the Secretary of the Interior, also allow the limited grazing of sheep and goats within such reserve. Permission to graze sheep and goats within the reserves will be refused in all cases where such grazing is detrimental to the reserves or to the interests dependent thereon, and upon the Bull Run Forest Reserve in Oregon, and upon and in the vicinity of Crater Lake and Mount Hood, or other well-known places of public resort or reservoir supply. The pasturing of live stock, other than sheep and goats, will not be prohibited in the forest reserves so long as it appears that injury is not being done the forest growth and water supply, and the rights of others are not thereby jeopardized. Owners of all live stock will be required to make application to the Commissioner of the General Land Office for permits to graze their animals within the reserves. Permits will only be granted on the express condition and agreement on the part of the applicants that they will agree to fully comply with all and singular the requirements of any law of Congress now or hereafter enacted relating to the grazing of live stock in forest reserves, and with all and singular the requirements of any rules and regulations now or hereafter adopted in pursuance of any such law of Congress; and upon failure to comply therewith, the permits granted them will be revoked and the animals removed from the reserves. Permits will also be revoked for a violation of any of the terms thereof, or of the terms of the applications on which based.

PRINCIPLES FOR FUTURE REGULATIONS FOR GRAZING IN THE RESERVES.

In the future, the following principles, lately announced by the Secretary of the Interior, will be the basis of all grazing regulations in the reserves. The central idea is cooperation between the Government and the grazing interests in securing the best management and bringing about the best condition of the range.

(1) The Government, through its forest officers, after consultation with the representatives of the various interests involved, should decide on the number of head to be grazed in each forest reserve, or each subdivison of a reserve, and should establish the boundaries between cattle range and sheep range.

(2) The local association should assign ranges to owners within the limits thus laid down, subject to official approval.

(3) Both owners and local associations should be held responsible for the observance of the terms of permits and the prevention of fire and overgrazing.

(4) Each sheep owner should have the exclusive right to his range, and the same should apply within reasonable limits to groups of cattle owners.

(5) Permits should run for five years.

(6) Residents should have precedence in all cases over tramp owners and owners from other States.

(7) Local questions should be decided on local grounds and on their own merits in each separate case.

(8) Since the forest reserves are usually summer ranges, provision should be made for necessary routes of transit.

(9) The policy of the Government should be based on regulation rather than prohibition, except in special cases, it being understood that the avoidance of overgrazing is equally in the interests of all parties.

Grazing of sheep is permitted in parts of eight of the reserves. Cattle are allowed in all. Anyone wishing to use the reserve pastures must obtain a permit. These permits are granted free of charge; the number of animals is limited, and the time of entrance into and exit from the reserve, as well as the district where they are to graze, is decided by the Department of the Interior.

In carrying out these principles the rules now adopted are: Wherever an association of sheep men exists, which represents the majority of those who have for at least two years used the reserve pastures, such an association is recognized. Blank applications are sent to the secretary of the association, and he distributes them and gets them filled and signed. He then transmits them to the supervisor, and the latter to the Department, when permit is issued. To set forth more definitely the requirements of the Department and the conditions of such a permit, the following appears printed on every application and permit:

This application is also made with the understanding, and full agreement thereto, that penalties will be imposed for a violation of rules as follows:

PERMITS CANCELED AND REFUSED.

1. For obtaining or attempting to obtain a permit on false representations.
2. For willful trespass upon areas where not permitted, either on closed areas or the ranges of others.
3. For setting out fires to clear range.
4. For *willful* negligence in leaving camp or other fires.
5. For refusing to observe promptly any direct order from the Department requiring an observance of any rule.

OTHER PENALTIES.

The number of sheep covered by a permit to be materially reduced for the following stated causes, viz:

1. For crowding onto a neighbor's range without the consent of said neighbor.
2. For bedding sheep more than six nights in succession in any one place, except when bedding bands of ewes during lambing season.
3. For entering the reserve prior to the date authorized.
4. For remaining in the reserve after the permit has expired.
5. For corralling within five hundred yards of a running stream or living spring.

6. For gross carelessness in leaving camp fires.

7. For failure to aid in extinguishing a fire occurring within the range occupied when possible to do so.

8. And for such other minor violations of the rules as may occur.

9. For failure to remove sheep promptly upon order of forest officer when damage is being done to the range.

10. For failure of herder to corral for count, upon order of forest officer or ranger, when number of sheep appears to be greater than the number covered by permit.

I also agree to forfeit the permit for a violation of any of its terms or of the terms hereof or whenever an injury is being done the reserve by reason of the presence of the animals therein.

(Signed) ——— ———.

EXTENT OF GRAZING IN THE RESERVES.

The following tables show the extent of grazing in the reserves:

Sheep grazing in the reserves in 1901.

Reserve.	Area in reserve.	Number of sheep allowed in reserve.	Grazing season allowed for calendar year 1901.	Number of permits issued.	Number of sheep covered by permits issued.
	Acres.				
Black Mesa, Arizona	1,658,880	225,000	April 1 to December 1	57	176,486
San Francisco Mountains, Arizona.	975,360	125,000	do	[a]20	90,700
Gila River, New Mexico	2,327,040	225,000	January 1 to August 31	30	134,320
Uinta, Utah	875,520	200,000	July 1 to October 1	87	188,050
Cascade Range, Oregon	4,588,800	200,000	June 15 to October 15	44	166,050
Big Horn, Wyoming	1,147,840	150,000	June 1 to September 20	[b]54	150,000
Mount Rainier, Washington	2,027,520	250,000	July 1 to September 25	89	249,713
Washington, Washington	3,426,400	25,000	do	[c]6	25,000
Total		1,400,000		387	1,180,318

[a] Five additional applications covering the remainder of the sheep allowed are pending.

[b] Thirty-four additional applications covering 99,400 sheep were rejected.

[c] Sheep allowed only in Okanogan County.

Cattle and horse grazing in the reserves in 1901.

Reserve.	Area in reserve.	Stock allowed to enter the reserve.			Stock covered by permits issued.			
		Cattle.	Horses.	Cattle and horses combined.	Permits issued.	Cattle.	Horses.	Cattle and horses combined.
	Acres.							
Black Mesa, Arizona	1,658,880	25,000	5,000	30,000	97	15,618	2,259	17,877
Prescott, Arizona	423,680	2,500	1,000	3,500	9	77	15	92
Grand Canyon	1,851,520	10,000	2,500	12,500	15	505	516	1,021
San Francisco Mountains, Arizona	975,360	20,000	5,000	25,000	110	11,311	3,364	14,675
Gila River, New Mexico	2,327,040	55,000	10,000	65,000	183	41,061	4,618	45,679
Pecos River, New Mexico	431,040	10,000	2,500	12,500	147	3,757	845	4,602
Lake Tahoe, California	136,335			[a]2,500	13	1,780	205	1,985
Stanislaus, California	691,200			[a]8,000	39	6,603	692	7,295
Sierra, California	4,096,000			[a]30,000	180	24,775	1,090	25,865

[a] Each horse to count as two head of cattle.

Cattle and horse grazing in the reserves in 1901—Continued.

Reserve.	Area in reserve.	Stock allowed to enter the reserve.			Permits issued.	Stock covered by permits issued.		
		Cattle.	Horses.	Cattle and horses combined.		Cattle.	Horses.	Cattle and horses combined.
Pine Mountain and Zaka Lake, California	*Acres.* 1,644,594	.....	.....	(a)	20	893	40	933
Santa Ynez, California	145,000	.....	.....	(a)	12	38	48	86
San Bernardino, California	737,280	.....	.....	(a)	18	3,005	40	3,045
San Gabriel, California	555,520	.....	.....	(a)	25	266	131	397
San Jacinto, California	737,280	.....	.....	(a)	16	1,080	.....	1,080
Trabuco Canyon, California	109,920	.....	.....	(a)	4	210	.....	210
Battlement Mesa, Colorado	858,240	.....	.....	47,000	149	43,065	3,931	46,996
Pikes Peak, Colorado	184,320	.....	.....	4,800	16	1,374	46	1,420
Plum Creek, Colorado	179,200	.....	.....	7,500	43	3,686	229	3,915
South Platte, Colorado	683,520	.....	.....	26,000	82	13,447	361	13,808
White River, Colorado	1,198,080	.....	.....	61,000	154	40,335	1,968	42,303
Fish Lake, Utah	67,840	.....	.....	2,100	5	370	4	374
Uinta, Utah	875,520	.....	.....	10,500	60	4,313	7	4,320
Bitter Root, Montana	691,200	4,000	2,000	6,000	1	400	0	400
Flathead, Montana	1,382,400	5,000	2,000	7,000	39	64	181	245
Gallatin, Montana	40,320	3,000	1,000	4,000	3	125	20	145
Lewis and Clark, Montana	2,926,080	20,000	7,000	27,000	52	5,968	775	6,743
Cascade Range, Oregon	4,588,800	3,800	550	4,350	12	1,535	10	1,545
Black Hills, South Dakota and Wyoming	1,211,680	.....	.....	7,000	166	5,720	1,276	6,996
Big Horn, Wyoming	1,147,840	.....	.....	15,000	128	13,805	1,179	14,984
Teton, Wyoming	829,440	.....	.....	2,000	32	1,742	212	1,954
Mount Rainier, Washington	2,027,520	.....	.....	6,000	94	5,689	240	5,929
Olympic, Washington	2,188,800	750	250	1,000	2	129	.....	129
Washington, Washington	3,426,400	.....	.....	7,500	0	0	.....	0
Total	.....	.....	.....	434,750	1,921	252,746	24,302	277,048

[a] Only the stock of settlers living within and immediately adjacent to the reserves allowed therein.

METHODS OF "RUNNING" STOCK AND THE EFFECTS ON RANGE AND WOODS.

Being mostly high mountain country, the reserve pastures can not be used throughout the year, but serve as summer range. The animals are wintered outside of the mountains, on a regular "winter range," usually extensive, dry prairie country where the snowfall is not sufficient to prevent grazing. Some of these winter ranges are practically desert regions through the summer, lacking both feed and water. Others furnish enough of forage, but the feed is dry and there is no drinking water on large portions of the districts, so that grazing on such ranges is poor and is limited to the vicinity of water holes or streams. (See Pl. XXXV.)

Generally, these prairie ranges are less suited as summer pasture to sheep than to cattle, since the latter stand the dry feed and intense summer heat better than do the sheep.

FIG. 1.—COMMON SHEEP RANGE. BLACK MESA RESERVE.

FIG. 2.—SHEEP RANGE ABOUT MOUNT ADAMS. MOUNT RAINIER RESERVE.

In the spring of the year the live stock is driven to the mountains and held there until the fall or winter storms drive them back to the winter range. In this way the reserve and other mountain pastures serve a rather peculiar function, and the indirect value of these mountain pastures is often greater than the direct value. They not only furnish pasture for a certain number of head of stock for a certain period, but by serving as summer range they make it possible to use large, arid regions for winter range, and thus greatly extend the grazing industry. For instance, the mountains included in the Mount Rainier Reserve have for years furnished summer range for about 250,000 head of sheep and several thousand head of cattle. Since the summer range outside of the reserve is mostly occupied and since the winter range is too dry to be used during summer, it may be said that the reserve pastures are essential to the maintenance of the bands in this section of Washington. It follows that closing these pastures would lead either to a reduction of the bands by about the number enjoying summer range, or to a radical change in the way of running sheep, and since these sheep represent a gross income of about $2 to $2.50 per head a year, such a reduction would materially affect the income of these communities until offset by the change just mentioned. With owners of cattle, usually farmers, near the boundaries of reserves the same conditions prevail. In the case of farmers and stockmen living within the reserves, the pastures of the reserves are, of course, their only available range, and, in many cases, are of more value to the farmers than the farms themselves.

Since the handling of sheep and cattle differs in many important points, the two cases are best considered separately, and since sheep grazing in the reserves is at present the more important of the two, it will be considered first.

SHEEP GRAZING.

TIME OF ENTERING THE RANGE.—The sheep of the Western mountain regions (generally "grade" Merinos and coarse-wools mixed) are owned for the most part by residents of the counties in which the reserves lie. They are run in flocks or "bands" of 2,000 to 3,000 head, in charge of a herder who is assisted by a "camp tender," "packer," or "camp rustler," whose business it is to look up range, move camp, and "pack" in supplies, including salt for the sheep.

The time of entering the reserves naturally varies with the climate of the particular district. In the northern reserves the herds are lambed and sheared before they begin their journey to the mountains, but in the southern reserves, as, for instance, the Black Mesa of Arizona, the shearing commonly precedes the lambing, the latter taking place in the reserve, and in some cases the sheep are sheared and lambed in the reserve.

Accordingly, the sheep enter the Black Mesa as early as April, while those of Mount Rainier do not reach the reserve line before the

middle of June or the beginning of July. Similarly, the sheep of the Black Mesa remain in the reserve until November; those of the Rainier, Big Horn, etc., are driven out by the fall storms as early as from the middle to the end of September.

Of late years a definite time of entering and leaving the reserve has been prescribed for each reserve, according to location and other conditions, much to the improvement of the range and also to the general satisfaction of the better sheep men.

JOURNEY TO THE MOUNTAINS.—In their journey to the mountains the sheep are usually obliged to follow certain natural highways, and their progress and the work of handling them is largely governed by the surroundings. Wherever possible, the sheep are allowed to travel slowly and graze as they go. Where these bands are obliged to move right along, as, for instance, in rocky defiles, patches of timber, etc., where no feed exists, the band is held close, the sheep are obliged to crowd closely together, and in consequence the trail takes on somewhat the appearance of a wide, much-traveled road. The small vegetation is destroyed, the ground is worn into numerous rut-like trails, and the bushes and small trees along these trails are rubbed and nibbled, and in some cases more or less barked and killed. Since these trails are commonly 50 to 100 yards in width, they are very conspicuous, and since they usually serve for ordinary travel as well as for the sheep, they are seen by many, and often, no doubt, the condition of the range, on the whole, is judged by these unsightly trails.

Where many bands travel the same trail and occupy the same summer range there is considerable rivalry, and in crowded districts the journey into the mountains often becomes a regular race for the better camps, much to the detriment of the sheep and range. Before the time of entrance was definitely regulated, men would start early and follow closely upon the receding snow. The freshly shorn sheep were exposed to the severities of storms, and were exhausted by rapid traveling. The range suffered even more—the ground was still wet, the feet of the animals sank deeply, and the sod was cut and damaged. In addition, the grass had just started; it was still too short to make good grazing, and thus the sheep were induced to run, and required extra moving. In this way considerable areas in nearly all reserves were completely ruined. The result is that the mat of vegetation has disappeared and the ground is bare.

A proper reduction of the number, the regulation of the time of entrance, and the division of the range have done much to prevent these injuries, and in some places a reclothing of such areas has been observed.

OCCUPATION OF THE RANGE.—The manner of occupation of the summer range differs in different reserves. Thus, in the Big Horn the several bands go wherever there is room and feed, the same band

FIG. 1.—PINE NIBBLED BY SHEEP. BIG HORN RESERVE.

FIG. 2.—PINE NIBBLED BY SHEEP. BLACK MESA RESERVE.

FIG. 1.—SHEEP IN THE OPEN-PARK WOODS OF YELLOW PINE (PINE SEEDLINGS SURE TO SUFFER). BLACK MESA RESERVE.

FIG. 2.—CONDITIONS UNDER WHICH THE SEEDLINGS SUFFER. BLACK MESA RESERVE.

occupying any part in the opened portion of the reserve. In the Rainier the range is divided into sheep and cattle ranges, the sheep range being divided into five well-defined districts, and each band of sheep receives a permit for only one of these districts. This measure has proven of great value by reducing the needless roaming of the numerous bands. In a few localities this division is carried a step further, and each man claims a certain territory or range by right of priority, in some cases reinforced by the fact that the stockman owns some lands within the range, including usually the best watering places, with some buildings and other improvements.

Generally, the law of priority prevents one herder from crowding in on the range of another, but when the entire range is crowded and feed is short, as in dry seasons, necessity sets aside all established rules.

THE MANNER OF GRAZING.—The grazing itself is quite similar everywhere. In the morning the band leaves camp, spreads out when it reaches good feed, grazes for some hours, rests during the warmer part of the day, resumes grazing, and toward evening returns to camp, where it is "bedded" on a piece of well-drained ground, preferably an open hillside.

Where a camp is used for a considerable time, especially in the case of large bands, this daily return to the same bedding ground is one of the most objectionable features of sheep grazing in the mountains. On the bedding ground itself everything is destroyed, and the ground is covered with a deep layer of manure which, if the sheep are bedded near a stream, washes down into the stream during heavy rains, and thereby pollutes the water.

In a fresh camp the sheep spread out at once in the morning and feed away from camp. But after some nights of bedding in the same spot, the ground about the camp ceases to have palatable feed, and the sheep merely travel over it, usually in a dense body, with from 10 to 50, traveling in the characteristic single file. This soon cuts the ground and grass along definite lines, and in a couple of weeks there are dozens of rut-like trails leading in all directions from the camp. This naturally grows worse, and each day sees more of this cutting of trail than the preceding, since the distance becomes greater and greater. That this evil is worse with larger bands than with smaller ones, and that it is worse on the poorer and closer-cropped ranges and during unfavorable seasons, is self-evident.

If the camp is located near or in timber, this frequent, forced return to the same bedding ground leads the sheep to mutilate young trees by nibbling and rubbing, even though they do not care for any part of the trees as forage. But what is even worse, the frequent march over the same ground by densely massed bodies of sheep necessarily destroys much young growth, particularly in the seedling stage. (Pls. XXXVI and XXXVII.)

In addition to the injury to range and woods, this persistent trailing back and forth to camps naturally affects, or rather disturbs, the surface conditions of the ground. Keeping in mind our illustration of the layer of earth on the table, it is clear that the cutting short of the grass cover, or the forest floor, has some influence on the run-off of water, and that this influence invariably is to increase the rate of run-off, and thereby the power of the water to carry away the soil. That the many thousands of little trails, cut as they are in parallel lines along the hillsides of every valley, naturally act as so many ditches, facilitate greatly the run-off, and establish definite lines of erosion, is equally clear.

HERDING.—In herding through the day, the sheep rarely go much more than one mile from camp, generally less. The herding itself depends mostly on the herder, but also on the character of sheep and range. Some men keep the sheep close together, and move them along while feeding; others allow them to spread as they please, and merely watch them to avoid loss from straying off and from wolves, etc. Where the sheep are held close, the strongest ones usually form the front and sides of the band, and get the pick of the feed, while the poorer ones in the center and rear must content themselves with the leavings. This naturally leads to restlessness, and involves much useless travel, which is still increased by the frequent use of the dog. At every turn the dog is sent to drive back, and every time he does so the feeding of part of the band is interrupted, and there is more or less crowding and running, which in every case means trampling and destroying of feed instead of using it. It should not be inferred that this close herding is always a mere matter of disposition or due to lack of experience, for such is not the case. During and just after lambing, in territory with many wolves, on old burns with much down timber, on very rough and rocky ground, in "brushy" country, in some cases during storms, and in fact wherever it is impossible to see the sheep a long distance, and where there is danger of straying off, close herding is necessary, and a certain amount of this must, therefore, always be expected.

FOOD PREFERRED.—The feed in these mountains is usually divided into three classes—grass, "weeds" (herbaceous vegetation other than grass), and "browse" (leaves and twigs of shrubs and trees). Most camps or ranges contain all three. Regular browse camps are the exception, and an all-grass range is rarely satisfactory sheep ground. In feeding, the sheep loves variety, prefers the short green feed, takes nearly everything, and thus cuts clean and close. On nearly all ranges this close cropping, together with the trampling, kills out some of the less resistant grasses and other plants and leaves the ground to the more resistant. A common and well-known example of this is seen where the mountain bunch-grass is killed out, frequently leaving the ground more or less bare for some time, when the more resistant grasses restore the cover.

Generally, the sheep do not eat any of the conifers or real forest trees of these mountains. They nibble them and injure them by crowding and nibbling about bedding grounds and along trails, and they feed on young trees and boughs of conifers in cases of dire necessity, but by far the greatest injury to tree growth undoubtedly consists in the trampling of seedling trees.

SOME RESULTS OF GRAZING ON THE RANGES.—In all cases of grazing the range is cut close, and this close shaving of the vegetable cover, together with the loosening of the soil, especially on all hillsides, naturally results in an appreciable change of the surface conditions and consequent surface run-off.

That lazy herding, where a camp is fairly "worn" out, and that all overstocking, and consequent overgrazing, increase the several kinds of injury here pointed out, goes without saying.

But while it is thus quite evident, therefore, that sheep grazing can never be conducted without more or less injuries, it is unfair to suppose, as has been too often the case, that grazing always results in serious mischief, and should, therefore, be forbidden.

To be sure, the bedding ground and trail are unsightly wastes, but they form a very small percentage of the entire area and in many cases occupy rough, rocky waste ground, of little importance for any purpose. In addition, it must be stated that the best sheep men have given up the old method of bedding for long periods in the same place and are adopting the proper way, bedding only one or at least only a few nights in a place; also, that most of the ordinary bedding grounds rapidly recover and, when once reclothed with grass, far excel the surrounding ground, so that many of these old bedding grounds are conspicuous by the luxuriance of their vegetation.

Similarly, the damage to the forest growth, even along the trails and about bedding grounds, has so far proven a serious permanent mischief only in a few special localities, such as parts of California and Arizona, where unfavorable peculiarities of climate and soil combine to resist the reproduction of the forest, and therefore need but little assistance, supplied by the sharp foot of the grazing animal, to prevent young growth altogether. In other localities, such as the Big Horn, the Rockies of Montana, and the Cascades of Washington, one meets some of the finest cases of natural reproduction of pine in the immediate vicinity of trails and bedding grounds. Such cases demand consideration, and seem to throw much doubt on the sweeping statements commonly made.

In the same way the matter of aggravated erosion due to grazing seems often overdrawn. As above indicated, there is no grazing without disturbance of the surface conditions, and there are numerous instances on record where overgrazed areas (overgrazed by cattle as well as by sheep) have begun to "gully," and otherwise show serious signs of mischief from erosion. Even in the many districts where a

more resistant soil has so far held firm, and the general appearance is such as to mislead most men into the belief that no disturbance exists, a closer scrutiny usually proves that all badly treated, overgrazed areas have suffered injury, and that a more general injury may be looked for in time. Nevertheless, it must be conceded that in several of the reserves the disturbance due to this cause is thus far insignificant, and that it is reasonable, therefore, to suppose that with proper limitations grazing may be carried on without great damage.

In judging the mischief done by sheep to the range itself, it is a common error to mistake a short-cropped range for a poor or injured range. Some of the older ranges, like the Red Desert of Wyoming, were on this account supposed to be "all killed out" more than fifteen years ago, and yet these very same ranges support as many sheep as ever, and support them fully as well. Similarly, parts of the Cascades have been used, and used hard, for many years, but in spite of being closely cut, and in spite of the fact that the tall bunch grass has long disappeared, the bands do as well as ever. This fact is so well known that it has misled many of the stockmen into the belief that since it is true with them it must be true everywhere. Such, however, is not the case. In some of the California and Arizona districts the mountain range, like that of parts of the lowland prairies, has been destroyed by overstocking, and there is good reason to believe that unlimited grazing, like unlimited lumbering, will result everywhere in general destruction of range as of forest. (Pl. XXXVIII.)

FIRING THE WOODS OF THE RANGE.—A mischief far more serious than any above mentioned, namely, that of setting fire to the woods, is often charged to the sheep industry, as though it were one of the natural consequences of this business. How far these charges are based upon prejudice against the sheep industry is difficult to say. To charge the sheep men with the many burns seems hardly fair, since the ungrazed portions of the same reserve often present as many and as extensive burns as do the regular ranges. Similarly, it seems to be now quite generally conceded that little, if any, benefit is derived from setting fire to the range, a practice quite common in the pineries of the South and elsewhere. Frequently it was argued that because many of the reserve pastures are located in burns it was fair to assume that these reserve pastures might be, and probably were, improved and extended by fires.

As matters stand, it would appear from observation and evidence that none of the reserve ranges are materially benefited by firing. Being mountain pastures, the feed is green; and being closely cropped, there is no need of removing tall dead grass, as is the case where firing is practiced. In dense, standing timber and windfalls fires usually produce sufficient heat to destroy all vegetation, and in addition leave the ground in such a condition that there is little or no feed for years. To set fire in such a place the herder endangers his camp outfit and

IN THE GILA RESERVE, WHERE GRAZING NEEDS REGULATION.

Yearbook U. S. Dept. of Agriculture, 1901.

FIG. 1.—TALL GRASS, WHERE FIRE IS APT TO SPREAD. BLACK MESA RESERVE.

FIG. 2.—SHEEP RANGE IN TALL WOODS.

sheep, loses a large amount of valuable feed, and can not hope to gain any material benefit for a number of years, by which time he will in all likelihood have abandoned the particular range.

While carelessness in the management of camp fires, etc., is possible with sheep herders, as with other persons, it must be granted that their experience, together with their material interests, would naturally check and correct such deficiencies. In addition, it seems proper to state that the experience with fires in the Big Horn Reserve during the summer of 1900 clearly proves that with a cordial cooperation of sheep men and rangers, the former furnish a very desirable body to draw from in case of emergencies. Where it requires from two to four days to fetch men from beyond the limits of the reserve, such assistance from the sheep men may be of the greatest importance.

In denying the charges of firing the woods, the sheep men correctly point out that the closely fed park lands are less liable to be fired, and that in many cases fires have actually come to an end when reaching closely cropped sheep ranges. (Pl. XXXIX.)

CATTLE GRAZING.

As stated above, the grazing of cattle is not forbidden. The cattle are owned mainly by farmers and small stockmen living near or in the reserve. Generally, and very properly so, a definite range is set aside for cattle, from which sheep are entirely excluded. Usually a number of cattle owners join in bringing their cattle into and out of the mountains.

Like sheep men, the owners of cattle make application to the supervisor for the privilege of grazing their stock in the reserve. To residents within the reserve whose herds do not exceed 100 head the supervisor may grant the grazing privilege himself; all other applications he merely transmits to the Department of the Interior with his recommendations, and the permit is issued by the Secretary. As in the case of sheep men, preference is given to the different cattlemen in the following order: (*a*) Residents within the reserve; (*b*) persons owning farms or lands within the reserve; (*c*) persons living near the reserve; (*d*) persons living distant from the reserve.

Persons not residing in the State where the reserve is located and persons not citizens of the United States are debarred entirely.

On the whole, the cattle brought from the plains dislike the mountains, and in many cases require to be kept there, either by fences erected across the valleys or by herders, whose duty it is to drive them back, keep them scattered, and salt them. By far the greater part of the cattle in the reserves are not herded; they are merely turned loose in the mountain parks and prairies, salted at regular intervals, and otherwise left without care or protection.

The cattle prefer the open parks, usually along the creeks; they dislike the denser woods, rough and steep ground, and high elevations.

They feed chiefly on grass and refuse weeds, and take little browse (except in some of the southern reserves). Cattle feed less closely than sheep, and being free, each animal travels only when it wants to, mostly to and from water. They use much less of the entire area of the reserve, and take only a portion, often the smaller portion, of the feed.

That cattle do no damage at all, as is so often claimed, is not true. Cattle cut trails on all hillsides, particularly in the vicinity of water. They are filthy about watering places, standing often for hours in and about the water and trampling many springs into unsightly mires; occasionally they browse; they bark trees by rubbing, and they naturally trample seedling trees, just as any other animal would. Being loose footed, there should be less trampling; but this is not always the case, since cattle by their very laziness are apt to stay more persistently on any given small area. That cattle do less harm to the range is only partly true. They crop it less closely, but choosing only grass and leaving the weeds, many a cattle range has been changed into a "weed patch." That overgrazing and consequent increase of all injuries is possible with cattle as with sheep is self-evident, and has been fully established on a number of ranges.

Numerous suggestions have been made for the restriction of grazing in the forest reserves. The most urgent and weighty of petitions of this kind come from the farmers in the vicinity of the reserves, who see in these mountain forests the protection for their all-important water supply. These petitions are fully considered each year in the allotments, and whenever the presence of sheep or cattle in these mountains appears to seriously endanger important agricultural interests it is but natural that the principle of the greatest good to the greatest number should prevail.

For a better regulation of the grazing, it has been suggested that, at least for sheep, and preferably also for cattle, the ranges be subdivided as far as the mountainous character of the reserves permits, and that each stock owner be allotted a well-defined range. This, as was correctly pointed out several years ago by Mr. Frederick V. Coville, Botanist of the Department of Agriculture, in his bulletin on the grazing in the Cascade Reserve of Oregon, would induce the stockman to care for his range, to protect it against fire, and to improve it by seeding or otherwise, and would prevent heedless overgrazing.

To carry out such a system would entail considerable additional expense upon the Government, and it has therefore been suggested that a per capita tax or rental should be imposed on all stock grazing in the reserves.

Though there is still considerable opposition to such a system, it may be said that nearly all of this opposition to-day does not come from the resident, permanent stockmen, but comes mostly from men who run stock wherever there is open range, avoiding all responsibility and owning little outside of their herds.

INSECT INJURIES TO FOREST PRODUCTS.

BY

A. D. HOPKINS,

In Charge of Forest Insect Investigations, Bureau of Entomology.

[REPRINT FROM YEARBOOK OF DEPARTMENT OF AGRICULTURE FOR 1904.]

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INSECT INJURIES TO FOREST PRODUCTS.

By A. D. Hopkins,
In Charge of Forest Insect Investigations, Bureau of Entomology.

CHARACTER AND EXTENT OF INJURY.

The detrimental and destructive work of insects which cause serious losses in commercial woods, barks, nuts, etc., consists of burrows or galleries excavated by the young and matured forms of beetles and a few other kinds of insects.

Round timber, rough lumber, and other crude products are seriously injured by pinhole and wormhole defects caused by a class of wood-boring beetles and grubs.

Seasoned rough and dressed lumber and finished wood material is damaged or completely destroyed by a class of so-called powder post borers, which convert the woody tissue into a mass of fine dust or powder.

Construction timbers and other wood material utilized in buildings, bridges, railroad construction, mining, etc., are often infested by wood-boring grubs, powder post borers, white ants, and other insects, to their serious detriment or destruction.

Stored oak and hemlock bark for tanning purposes is, under certain conditions, seriously damaged or destroyed by insects which infest the inner or "flesh" parts and convert them into a fine powder.

Medicinal barks, roots, and leaves are also bored or eaten by drug beetles, causing injuries which, while not necessarily destroying the medicinal qualities, are detrimental to the commercial value of such material.

From the writer's personal investigations of this subject in different sections of the country, the damage to forest products of various kinds from this cause seems to be far more extensive than is generally recognized. Allowing a loss of 5 per cent on the total value of the forest products of the country, which the writer believes to be a conservative estimate, it would amount to something over $30,000,000 annually. This loss differs from that resulting from insect damage to natural forest resources in that it represents more directly a loss of money invested in material and labor.

KNOWLEDGE NECESSARY TO PREVENTION OF LOSSES.

In dealing with the insects mentioned, as with forest insects in general, the methods which yield the best results are those which relate directly to preventing attack. In order to meet with the best success, however, it is necessary to have a complete knowledge of the insects which cause the injuries and the conditions which are attractive to them or otherwise favor their attack, as well as those which are unattractive or unfavorable.

The insects have two objects in their attack; one is to obtain food, the other is to prepare for the development of their broods. Different species of insects have special periods during the season of activity (March to November) when the adults are on the wing in search of suitable material in which to deposit their eggs. Some species which fly in April will be attracted to the trunks of recently felled pine trees or to piles of pine sawlogs from trees felled the previous winter. They are not attracted to any other kind of timber, because they can live only in the bark or wood of pine, and only in that which is in the proper condition to favor the hatching of their eggs and the normal development of their young. As they fly only in April, they can not injure the logs of trees felled during the remainder of the year. There are also oak insects, which attack nothing but oak; hickory insects, cypress insects, spruce insects, and so on, which have different habits and different periods of flight and require special conditions of the bark and wood for depositing their eggs or for the subsequent development of their broods. Some of these insects have but one generation in a year, others have two or more, while some require more than one year for their complete development and transformation. Some species deposit their eggs in the bark or wood of trees soon after they are felled or before any perceptible change from the normal living tissue has taken place; other species are attracted only to dead bark and dead wood of trees which have been felled or girdled for several months; others are attracted to dry and seasoned wood; while another class will attack nothing but very old dry bark or wood of special kinds and under special conditions. Thus, it will be seen how important it is for the practical man to have a knowledge of such of the foregoing facts as apply to his immediate interest in the manufacture or utilization of a given forest product, in order that he may, with the least trouble and expense, adjust his business methods to meet the requirements for preventing losses.

DISTINCTIVE CHARACTER OF INSECT INJURIES.

The work of different kinds of insects, as represented by special injuries to forest products, is the first thing to attract attention, and the distinctive character of this work is easily observed, while the insect

responsible for it is seldom seen, or it is so difficult to determine by the general observer, from descriptions or illustrations, that the species is rarely recognized. Fortunately, the character of the work is often sufficient in itself to identify the cause and suggest a remedy, and, in this paper, primary consideration is given to this phase of the subject.

AMBROSIA OR TIMBER BEETLES.

The characteristic work of this class of wood-boring beetles is shown in figures 43, 44, and 45. The injury consists of pinhole and stained-wood defects in the sapwood and heartwood of recently felled or girdled trees, sawlogs, pulpwood, stave and shingle bolts, green or

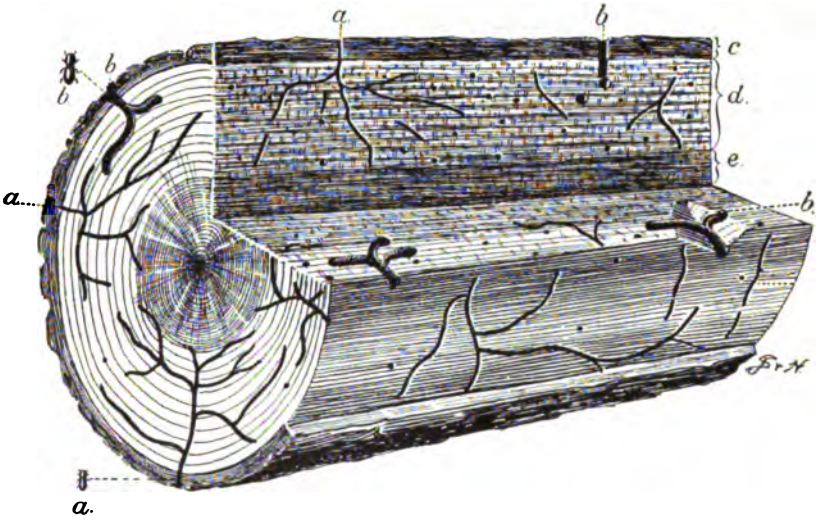

FIG. 43.—Work of ambrosia beetles in tulip or yellow poplar wood: *a*, work of *Xyleborus affinis* and *Xyleborus inermis*; *b*, *Xyleborus obesus* and work; *c*, bark; *d*, sapwood; *e*, heartwood. (Original.)

unseasoned lumber, and staves and heads of barrels containing alcoholic liquids. The holes and galleries are made by the adult parent beetles to serve as entrances and temporary homes or nurseries for the development of their broods of young, which feed on a kind of fungus growing on the walls of the galleries. The growth of this ambrosia-like fungus is induced and controlled by the parent beetles, and the young are dependent upon it for food. The wood must be in exactly the proper condition for the growth of the fungus in order to attract the beetles and induce them to excavate their galleries; it must have a certain degree of moisture and other favorable qualities which usually prevail during the period involved in the change from living, or normal, to dead or dry wood; such a condition is found in recently felled trees, sawlogs, or like crude products.

There are two general types or classes of these galleries—one in

which the broods develop together in the main burrows (figs. 43 and 44), the other in which the individuals develop in short separate side

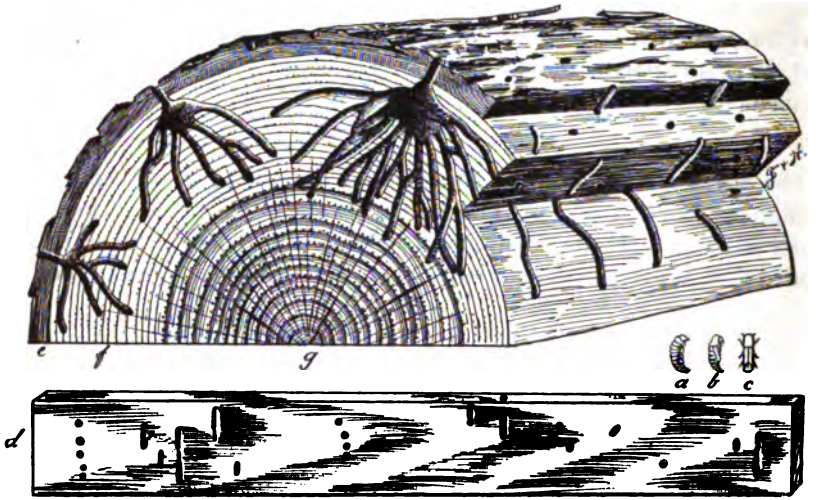

FIG. 44.—Work of ambrosia beetle, *Xyleborus celsus*, in hickory wood: *a*, larva, *b*, pupa; *c*, adult beetle, natural size; *d*, character of work in lumber cut from injured log; *e*, bark; *f*, sapwood; *g*, heartwood. (Original.)

chambers extending at right angles from the primary gallery (fig. 45). The galleries of the latter type are usually accompanied by a distinct staining of the wood, while those of the former are not.

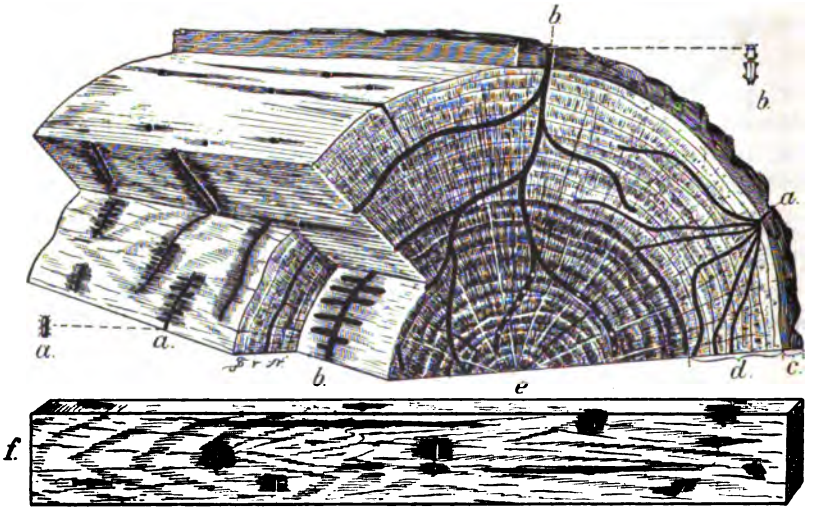

FIG. 45.—Work of ambrosia beetles in oak: *a*, *Monarthrum mali* and work; *b*, *Platypus compositus* and work; *c*, bark; *d*, sapwood; *e*, heartwood; *f*, character of work in lumber from injured log. (Original.)

The beetles responsible for this work are cylindrical in form, apparently with a head (the prothorax) half as long as the remainder of the

body (figs. 43, *a*, and 45, *a*). North American species vary in size from less than one-tenth to slightly more than two-tenths of an inch, while some of the subtropical and tropical species attain a much larger size. The diameter of the holes made by each species corresponds closely to that of the body, and varies from about one-twentieth to one-sixteenth of an inch for North American, and to one-eighth of an inch for the tropical species.

ROUND-HEADED BORERS.

The character of the work of this class of wood and bark-boring grubs is shown in figure 46. The injuries consist of irregular flattened or nearly round wormhole defects in the wood which sometimes result in the destruction of the valuable parts of wood or bark material.

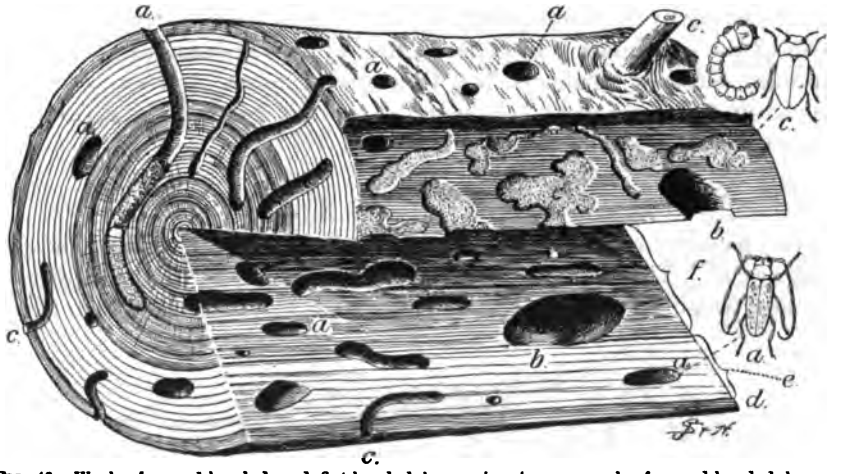

FIG. 46.—Work of round-headed and flat-headed borers in pine: *a*, work of round-headed borer, "sawyer," *Monohammus* sp., natural size; *b*, *Ergates spiculatus*; *c*, work of flat-headed borer, *Buprestis*, larva and adult; *d*, bark; *e*, sapwood; *f*, heartwood. (Original.)

The sapwood and heartwood of recently felled trees, sawlogs, poles, posts, mine props, pulpwood, and cordwood, also lumber or square timber with bark on the edges, and construction timber in new and old buildings, are injured by wormhole defects, while the valuable parts of stored oak and hemlock tanbark and certain kinds of wood are converted into worm dust. These injuries are caused by the young or larvæ of long-horned beetles. Those which infest the wood hatch from eggs deposited in the outer bark of logs and like material, and the minute grubs hatching therefrom bore into the inner bark, through which they extend their irregular burrows for the purpose of obtaining food from the sap and other nutritive material found in the plant tissue. They continue to extend and enlarge their burrows as they increase in size, until they are nearly or quite full grown. They then enter the wood and continue their excavations deep into the sapwood

or heartwood until they attain their normal size. They then excavate pupa cells in which to transform into adults, which emerge from the wood through exit holes in the surface.

This class of borers is represented by a large number of species. The adults, however, are seldom seen by the general observer unless cut out of the wood before they have emerged. Many of them fly at night, while others are so nearly the color of the bark on which they rest that they are difficult to find. The holes made by these borers vary in size from very minute to more than an inch in diameter, but the intermediate sizes are most common.

FLAT-HEADED BORERS.

The work of flat-headed borers is only distinguished from that of the preceding by the broad, shallow burrows and the much more oblong form of the exit holes. In general, the injuries are similar and affect the same class of products, but they are of much less importance. The adult forms are flattened, metallic-colored beetles, and represent many species, of various sizes.

TIMBER WORMS.

The character of the work done by the borers of this class is shown in figure 47. The injury consists of pinhole defects in the sapwood and heartwood of felled trees, sawlogs, and like material which have

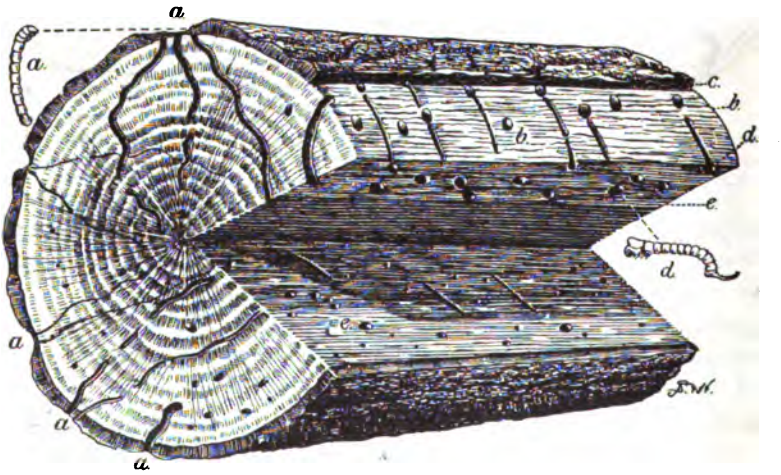

FIG. 47.—Work of timber worms in oak: *a*, work of oak timber worm, *Eupsalis minuta;* *b*, barked surface; *c*, bark; *d*, sapwood timber worm, *Hylocœtus lugubris*, and work; *e*, sapwood. (Original.)

been left in the woods or in piles in the open for several months during the warmer seasons. Stave and shingle bolts and closely piled oak lumber and square timbers also suffer from injury of this kind. These

injuries are made by elongate, slender worms or larvæ which hatch from eggs deposited by the adult beetles in the outer bark, or, where there is no bark, just beneath the surface of the wood. At first the young larvæ bore almost invisible holes for a long distance through the sapwood and heartwood, but as they increase in size the same holes are enlarged and extended until the larvæ have attained their full growth. They then transform to adults and emerge through the enlarged entrance burrows. The work of these timber worms is distinguished from that of the timber beetles by the greater variation in the size of holes in the same piece of wood; also by the fact that they are not branched from a single entrance or gallery, as are those made by the beetles.

POWDER POST BORERS.

The character of work of this class of insects is shown in figures 48, 49, 50, and 51. The injury consists of closely placed burrows packed with the borings or a completely destroyed or powdered condition of

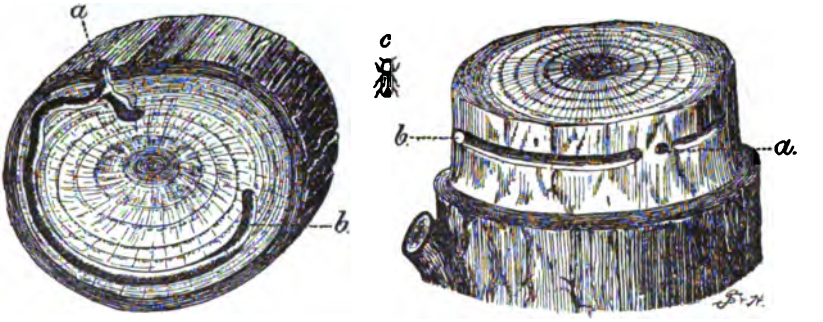

FIG. 48.—Work of powder post beetle, *Sinoxylon basilare*, in hickory poles, showing transverse egg galleries excavated by the adult: *a*, entrance; *b*, gallery; *c*, adult. Natural size (original).

the wood of seasoned products, such as lumber, crude and finished handle, cooperage, and wagon stock, furniture, and inside finish wood-

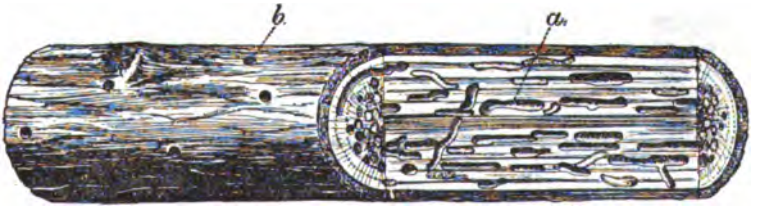

FIG. 49.—Work of powder post beetle, *Sinoxylon basilare*, in hickory pole: *a*, character of work by larvæ; *b*, exit holes made by emerging broods. (Original.)

work in old buildings, as well as in many other crude or finished and utilized woods. This is the work of both the adults and young stages

of some species, or of the larval stage alone of others. In the former, the adult beetles deposit their eggs in burrows or galleries excavated for the purpose, as in figures 48 and 49, while in the latter (figs. 50 and 51) the eggs are deposited on or beneath the surface of the wood. The grubs complete the destruction by boring through the solid wood in all directions and packing their burrows with the powdered wood. When they are full grown they transform to the adult and emerge from the injured material through round holes in the surface. Some of the species continue to work in

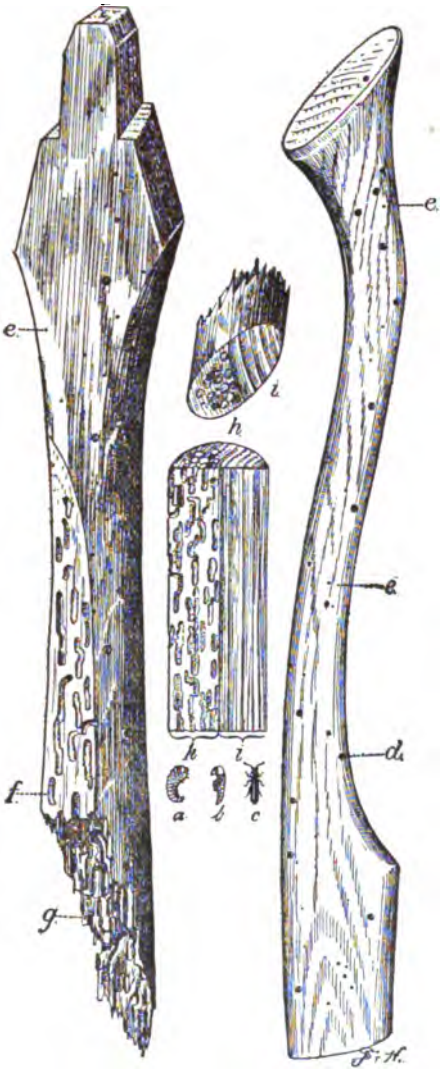

FIG. 50.—Work of powder post beetle, *Lyctus striatus*, in hickory handles and spokes: *a*, larva; *b*, pupa; *c*, adult, natural size; *d*, exit holes; *e*, entrance of larvæ (vents for borings are exits of parasites); *f*, work of larvæ; *g*, wood, completely destroyed; *h*, sapwood; *i*, heartwood. (Original.)

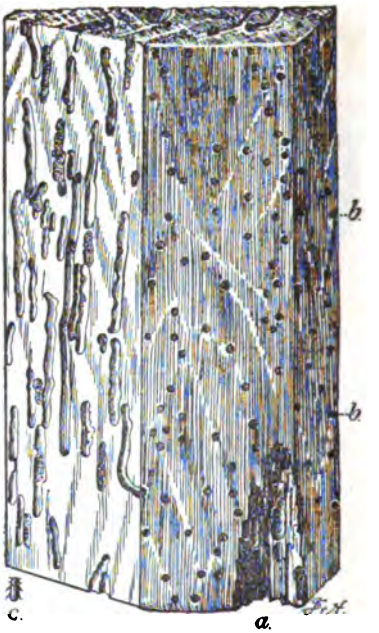

FIG. 51.—Work of powder post beetle. *Xylctinus paltatus*, in old pine flooring: *a*, work of larvæ; *b*, exit holes made by emerging broods; *c*, adult, natural size (Original.)

the same wood until many generations have developed and emerged, or until every particle of wood tissue has been destroyed and the available nutritive substance extracted.

WHITE ANTS, OR TERMITES.

The character of the work of white ants, or termites, in wood is shown in figure 52. It consists of burrows, galleries, and tunnels of greatly varying sizes, and of every conceivable shape, extended in all directions through the wood. A peculiar character is the complete destruction of the inner portion of the wood, while slight or no evidence is shown on the exposed surface. In this work these insects employ a kind of earthy matter mixed with macerated wood to cover or roof in such parts of the galleries as would otherwise be exposed to the light; also to cover their paths over the surface of stone, iron, or uninjured wood, where inside tunnels are not made, to protect them from light and from their enemies as they travel from place to place to visit or extend their burrows and nests.

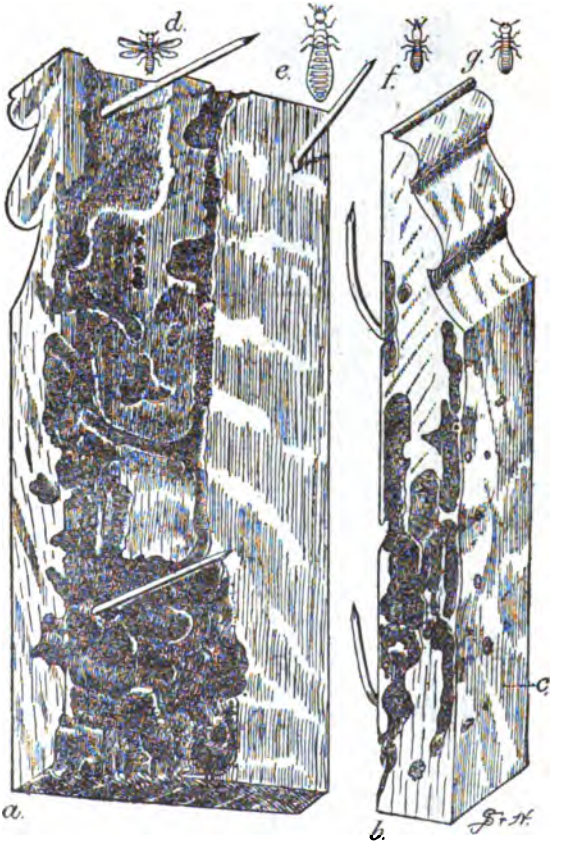

FIG. 52.—Work of white ant, or termite, *Termes flavipes*, in sound and dry red oak molding from door casing: *a*, inner portion; *b*, longitudinal section; *c*, outer surface; *d*, male; *e*, female; *f*, soldier; *g*, worker, natural size. (Original.)

The injuries to forest products, both crude and finished, consist of a partial or complete destruction of the infested material. Under certain conditions greater damage and loss is caused than by the work of any other class of insects. A great variety of products is affected, such as round and square timbers left for some time next to the ground, posts and poles set in the ground, railroad ties, bridge timbers, and lumber in the bottom of stacks; and these insects are especially destructive to the underpinning, flooring, and all other wooden parts of buildings which are readily accessible to the little destroyers. The excavations are made by the insects for the purpose of obtaining food and to serve as habitations and nurseries for the great number of individuals which occupy them.

These insects are not true ants, but resemble them somewhat in size and general appearance. They correspond in their social habits to ants and bees in that each colony includes workers, soldiers, males and females (winged or wingless), and a single royal pair.[a]

BLACK ANTS.

The work of the true ants in wood somewhat resembles that of white ants, and is done for the same or similar purposes and under similar conditions, but is much less common or injurious. It usually consists in the extension of the work or damage started by other wood-boring insects, through the galleries of which the black ant gains entrance to the inner wood, which is sometimes honeycombed.

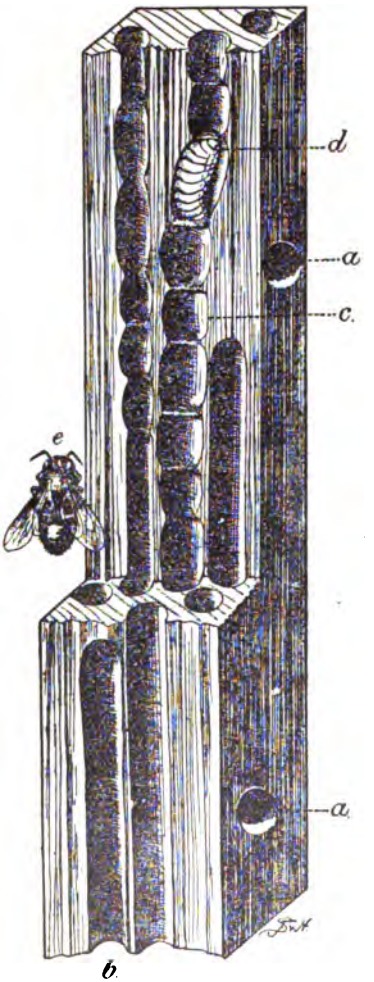

FIG. 53.—Work of carpenter bee, *Xylocopa orpifex*, in redwood lumber from San Jose, Cal.: *a*, entrance; *b*, galleries; *c*, cells; *d*, larva; *e*, adult—slightly reduced. (Original.)

CARPENTER BEES.

The work of this class of wood-boring bees is shown in figure 53. The injury consists of large augerhole-like tunnels in exposed solid dry wood of buildings and other structures. It is most common in soft woods, such as pine, poplar, redwood, and the like, the latter being especially liable to attack in California and the Southwest.

NUT WEEVILS AND THEIR ALLIES.

The characteristic work of this class of insects is a mined or mealy condition of the kernel or inner parts, the surface being pierced by round holes and otherwise injured or destroyed. The loss results from the worthless condition of the infested material as an article of commerce, as food, and for planting, whether naturally or artificially.

Many kinds of insects are responsible for injuries of this kind, such as weevils and other beetles, caterpillars of moths, and gall flies. In most cases where the inner portion of nuts or seeds is injured by weevils, the

[a] For further information on these insects, see article by C. L. Marlatt, in Bulletin No. 4. new series, of the Bureau of Entomology.

eggs are deposited in the young pods, so that the entrance burrows made by the minute young larvæ are completely hidden before the nuts are matured. After the larvæ in nuts complete their growth they bore their way out and enter the ground to pass the winter, and transform to the adult the next season. In certain kinds of seeds the transformation to the adult takes place within.[a]

DRUG BEETLES.

Injury by this class of enemies to certain medicinal products of the forest consists of the honeycombed, sieve-like, or powdered condition of certain kinds of barks, roots, stems, leaves, and seeds. The insects responsible for the work belong to the class of true powder post borers, and have similar habits.

CONDITIONS FAVORABLE FOR INSECT INJURY.

CRUDE PRODUCTS.

ROUND TIMBER WITH BARK ON.—Newly felled trees, sawlogs, telegraph poles, posts, and like material, cut in the fall and winter and left on the ground or in close piles during a few weeks or months in the spring and summer, are especially liable to injury by ambrosia beetles (figs. 43, 44, and 45), round and flat-headed borers (fig. 46), and timber worms (fig. 47), as are also trees felled in the warm season and left for a time before working up into lumber. The proper degree of moisture found in freshly cut living or dying wood, and the period when the insects are flying, are the conditions most favorable for attack. This period of danger varies with the time of the year the timber is felled and with different kinds of trees. Those felled in late fall and winter will generally remain attractive to ambrosia beetles and the adults of round and flat-headed borers during March, April, and May. Those felled in April to September may be attacked in a few days after they are felled, and the period of danger may not extend over more than a few weeks. Certain kinds of trees felled during certain months and seasons are never attacked, because the danger period prevails only when the insects are flying; on the other hand, if the same kinds of trees are felled at a different time, the conditions may be most attractive when the insects are active, and they will be thickly infested and ruined.

The presence of bark is absolutely necessary for infestation by most of the wood-boring grubs, since the eggs and young stages must occupy the outer and inner portions before they can enter the wood. Some ambrosia beetles and timber worms will, however, attack barked logs, especially those in close piles and otherwise shaded and protected from rapid drying. The sapwood of pine, spruce, fir, cedar,

[a] For further information on these insects, see article by F. H. Chittenden, Bulletin No. 44, Bureau of Entomology, pp. 24–43.

cypress, and like soft wood is especially liable to injury by ambrosia beetles, while the heartwood is sometimes ruined by a class of round-headed borers known as sawyers. Yellow poplar, oak, chestnut, gum,

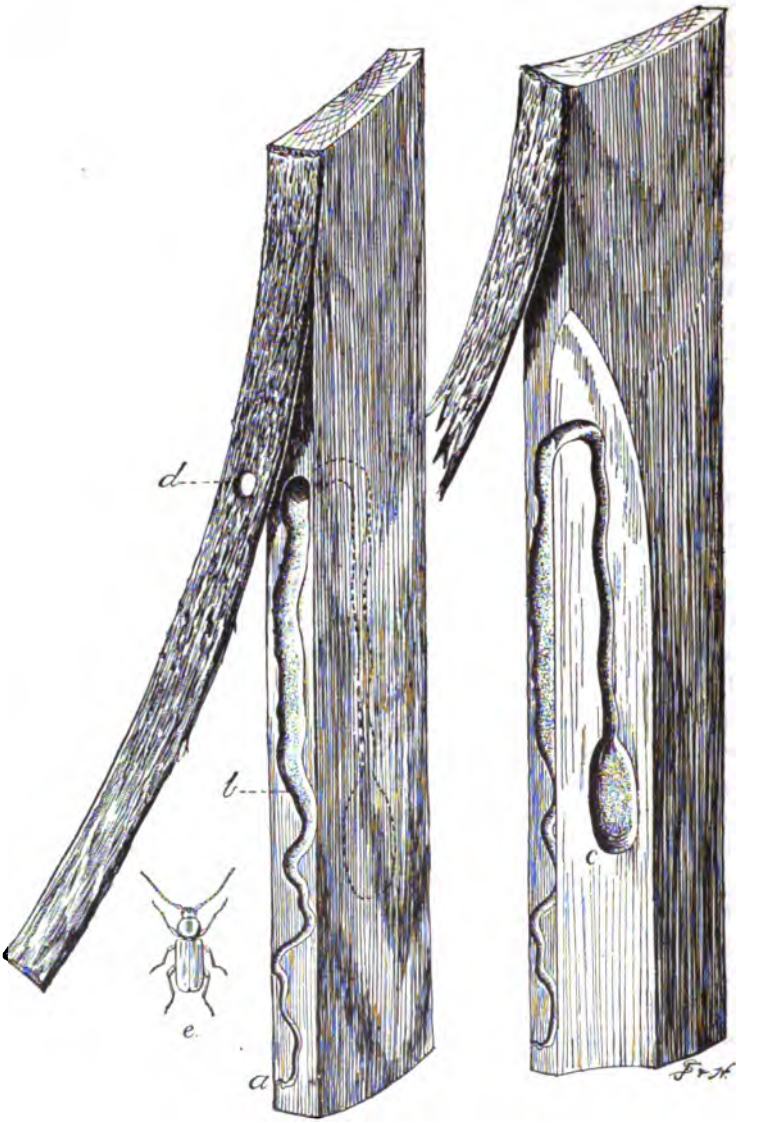

FIG. 54.—Work of round-headed borer, *Callidium antennatum*, in white pine bucket staves from New Hampshire: *a*, where egg was deposited in bark; *b*, larval mine; *c*, pupal cell; *d*, exit in bark; *e*, adult, slightly reduced. (Original.)

hickory, and most other hardwoods, are, as a rule, attacked by species of ambrosia beetles, sawyers, and timber worms different from those infesting the pines, there being but very few species which attack both.

Mahogany and other rare and valuable woods imported from the

Tropics to this country in the form of round logs, with or without the bark on, are commonly damaged, more or less seriously, by ambrosia beetles and timber worms. It would appear, from the writer's investigations of logs as received at the mills in this country, that the principal damage is done during a limited period from the time the trees are felled until they are placed in the fresh or salt water for transportation to the shipping points. If, however, the logs are loaded on the vessel direct from the shore, or if not left in the water long enough to kill the insects, the latter will continue their destructive work during transportation to this country and after they arrive until cold weather ensues or the logs are converted into lumber. It was also found that a thorough soaking in sea water, while it usually killed the insects at the time, did not prevent subsequent attack by both foreign and native ambrosia beetles; also, that the removal of the bark from such logs previous to their immersion did not render them entirely immune. Indeed, it was found that those with the bark off were attacked more than those with it on, owing, doubtless, to the greater amount of saline moisture absorbed and retained by the bark.

From the foregoing it will be seen that some requisites for preventing insect injuries to round timber are:

(1) To provide for as little delay as possible between the felling of the tree and its manufacture into rough products. This is especially necessary with trees felled from April to September in the region north of the Gulf States, and from March to November in the latter, while the late fall and winter cutting should all be worked up by March or April.

(2) If the round timber must be left in the woods or on the skidways during the danger period, every precaution should be taken to facilitate rapid drying of the inner bark, by keeping the logs off the ground, in the sun, or in loose piles; or else the opposite extreme should be adopted, and the logs kept in water.

(3) The immediate removal of all of the bark from poles, posts, and other material which will not be seriously damaged by checking or season cracks.

(4) To determine and utilize the proper months or seasons to girdle or fell different kinds of trees. Bald cypress in the swamps of the South are girdled in order that they may die and in a few weeks or months dry out and become light enough to float. This method has been extensively adopted in sections where it is the only practicable one by which the timber can be transported to the sawmills. It is found, however, that some of these girdled trees are especially attractive to several species of ambrosia beetles (figs. 43, 44, and 45), round-headed borers (fig. 46), and timber worms (fig. 47), which cause serious injury to the sapwood or heartwood, while other trees girdled at a different

time or season are not injured. This suggested to the writer the importance of experiments to determine the proper time to girdle trees to avoid losses, and they are now being conducted on an extensive scale, in cooperation with prominent cypress operators in different sections of the cypress-growing region.

SAPLINGS.—Saplings, including hickory and other round hoop poles and similar products, are subject to serious injuries and destruction by round and flat-headed borers (fig. 46) and certain species of powder post borers (figs. 48 and 49) before the bark and wood are dead or dry, and also by other powder post borers (fig. 50), after they are dried and seasoned. The conditions favoring attack by the former class are those resulting from leaving the poles in piles or bundles in or near the forest for a few weeks during the season of insect activity, and by the latter, from leaving them stored in one place for several months.

STAVE AND SHINGLE BOLTS.—These are attacked by ambrosia beetles (figs. 43–45) and the oak timber worm (fig. 47, *a*), which, as has been frequently reported, cause serious losses. The conditions favoring attack by these insects are similar to those mentioned under "Round timber." The insects may enter the wood before the bolts are cut from the log, or afterwards, especially if the bolts are left in moist, shady places in the woods in close piles during the danger period. If cut during the warm season, the bark should be removed and the bolts converted into the smallest practicable size and piled in such a manner as to facilitate rapid drying.

HANDLE AND WAGON STOCK IN THE ROUGH.—The crude material from which this class of products is manufactured is especially liable to injury by ambrosia beetles and round-headed borers, and, during the warmer seasons, special precaution is required to prevent damage. The conditions favoring attack of the round logs and bolts are the same as with other round timber. Hickory and ash in the round with the bark on are almost certain to be greatly damaged if the winter and spring cuttings are held over a few weeks after the middle of March or first of April.

PULPWOOD AND CORDWOOD.—Pulpwood is injured by ambrosia beetles and round-headed borers, and cordwood by the latter. The conditions favoring attack are those resulting from close piling, and leaving in the woods, or in shady damp places, from a few weeks after the first of April to the first of August. Material of this kind is sometimes riddled with holes, or converted into "sawdust," if left in close piles for a few months during the summer. This damage can be avoided, to a great extent, by placing the sticks of wood in triangular, or crib, piles immediately after they are cut from the tree—a common practice in the South. This facilitates rapid drying and renders the

wood immune. Peeling and splitting of the wood before it is piled is also desirable for the same purpose.

UNSEASONED PRODUCTS IN THE ROUGH.

Freshly sawed hardwood lumber placed in close piles during warm, damp weather in July and September presents especially favorable conditions for injury by ambrosia beetles (figs. 43, *a*, and 45, *a*.) This is due to the continued moist condition of such material. Heavy 2-inch or 3-inch stuff is also liable to attack even in loose piles with lumber sticks. An example of the latter was found in a valuable lot of mahogany lumber of first grade, the value of which was reduced two-thirds by injury from a native ambrosia beetle. Numerous complaints have been received from different sections of the country of this class of injury to oak, poplar, gum, and other hardwoods. In all cases it is the moist condition and retarded drying of the lumber which induces attack; therefore any method which will provide for the rapid drying of the lumber, before or after piling, will tend to prevent losses. It is important that heavy lumber should, as far as possible, be cut in the winter and piled so that it will be well dried out before the middle of March.

Lumber and square timber with the bark on the edges or sides often suffer from injuries by flat and round-headed borers hatching from eggs deposited in the bark of the logs before they are sawed or after the lumber has been sawed and piled. One example of serious damage and loss was reported in which white pine staves for paint buckets and other small wooden vessels, which had been sawed from small logs and the bark left on the edges, were attacked by a round-headed borer, the adults having deposited their eggs in the bark after the stock was sawed and piled. The character of the injury is shown in figure 54, page 392.

Another example was reported from a manufacturer in the South, where the pieces of lumber which had a strip of bark on one side were seriously damaged by the same kind of borer, the eggs having been deposited in the logs before sawing or in the bark after the lumber was piled. If the eggs are deposited in the logs and the borers have entered the inner bark, or the wood, before sawing, they may continue their work regardless of methods of piling; but if such lumber is cut from new logs and placed in the pile while green, with the bark surface up, it will be much less liable to attack than if piled with the bark down. This liability of lumber, with bark edges or sides, to be attacked by insects suggests the importance of the removal of the bark to prevent damage, or, if this is not practicable, the lumber with the bark on the sides should be piled in open, loose piles with the bark up, while that with the bark on the edges should be placed on the outer edges of the pile, exposed to the light and air.

A moist condition of lumber and square timber, such as results from close or solid piles with the bottom layers on the ground, or on a foundation of old decaying logs, or near decaying stumps and logs, offers especially favorable conditions for the attack of white ants.

SEASONED PRODUCTS IN THE ROUGH.

DRY LUMBER.—Dry lumber in stacks or storage is liable to injury by powder post borers (fig. 50). The conditions favoring attack are: (1) The presence of a large proportion of sapwood, as in hickory, ash, and similar woods; (2) material which is two or more years old or that which has been kept in one place for a long time; (3) access to old infested material. Therefore such lumber should be frequently examined for evidence of the presence of these insects. This is always indicated by fine flour-like powder on or beneath the piles, or otherwise associated with such material. All infested material should be at once removed and the infested parts destroyed by burning.

DRY COOPERAGE, WAGON, AND HANDLE STOCK.—These are especially liable to attack and serious injury by powder post borers (fig. 50), under the same or similar conditions as in the case of dry lumber.

FINISHED OR UTILIZED PRODUCTS.

TIMBERS AND OTHER WOODWORK IN NEW AND OLD BUILDINGS.—These are often injured by powder post borers (fig. 50), or white ants (fig. 52). If by the former in new structures, it indicates that infested material was used in the structure and that after being thus introduced the insects continued to breed and extend the injuries, regardless of paint and varnish or other external treatment which would otherwise prevent attack. If the trouble occurs in old buildings it is usually due to a large proportion of sapwood in the frame timbers, flooring, and other parts, which, owing to the age of such material, is rendered especially attractive to certain classes of powder post borers. After such wood is once infested, the insects continue to breed and extend their work for many years, or until all the sapwood is converted into powder. Figure 51 illustrates an example of pine flooring in an old barn which was damaged by one species of this class of insects.

The conditions in new or old buildings favorable for attack by white ants (fig. 52) are decayed or moist wood in the underpinning and foundation timbers which are near the ground, or the location of buildings in the vicinity of decaying wood of any kind in which the insects are breeding. After a building is once infested, however, the destructive work is extended into sound and dry wood. Old logs and stumps are favorite breeding places for these insects, from which they may travel or fly to a considerable distance to reach suitable places to extend

their work; therefore, it is important that all such material should be removed previous to the construction of buildings to prevent danger. The creosote treatment of frame timbers would doubtless prevent the attack of powder post borers.

WOODWORK IN WAGONS, FURNITURE, ETC.—This is often seriously damaged or destroyed by powder post borers (fig. 50), which are introduced by the use of infested wood, in which they continue to work regardless of paint and subsequent external treatment.

STAVES AND HEADINGS OF BARRELS CONTAINING ALCOHOLIC LIQUIDS.—These are liable to attack by ambrosia beetles (figs. 43, *a*, and

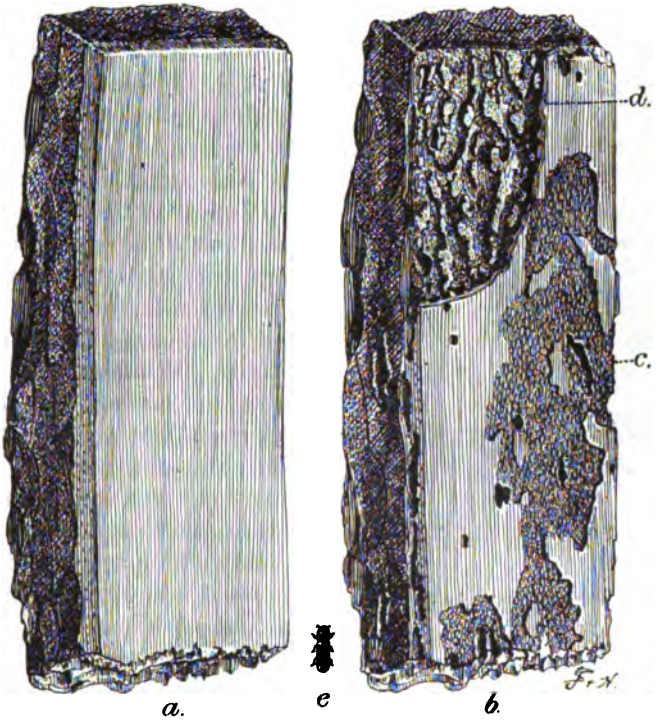

FIG. 55.—Work of the hemlock tanbark destroyer, *Dinoderus substriatus: a*, bark less than three years old, uninjured; *b*, bark over three years old; *c*, surface of inner bark eaten by adults; *d*, inner portion destroyed by larvæ and adults; *e*, adult, natural size. (Original.)

45, *a*), which are attracted by the moist condition, and possibly by the peculiar odor of the wood, resembling that of dying sapwood of trees and logs, which is their normal breeding place. There are many examples on record of serious losses of liquors from leakage caused by the beetles boring through the staves and headings of barrels and casks in cellars and storerooms.

The condition, in addition to the moisture of the wood, which is favorable for the presence of the beetles is proximity to their breeding

places, such as the trunks and stumps of recently felled or dying oak, maple, apple, and other hardwood or deciduous trees; lumber yards, sawmills, freshly cut cordwood from living or dead trees, and forests of hardwood timber. Under such conditions the beetles occur in great numbers, and, if the storerooms and cellars in which the barrels are kept are damp, poorly ventilated, and readily accessible to them, serious injury is almost certain to follow.

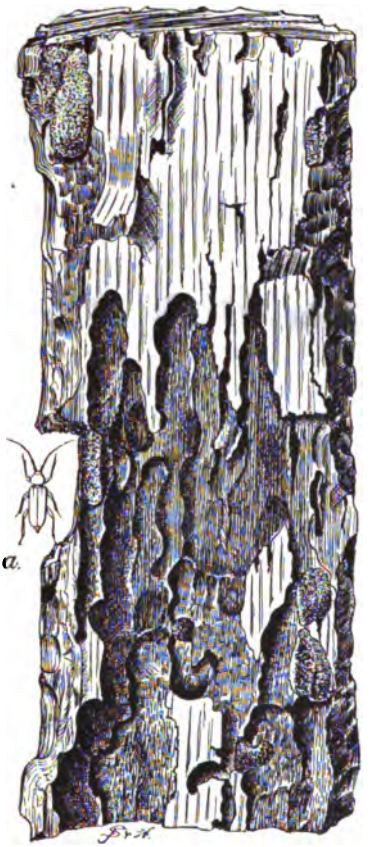

FIG. 56.—Work of round-headed borer, *Phymatodes variabilis*, in oak tanbark: *a*, adult. (Original.)

TANBARK.—Favorable conditions for insect attack and injury to tanbark (figs. 55 and 56) are found in that which is over three years old from the time it is taken from the tree. This suggests at once a simple and practical method of preventing losses—that of labeling the different lots, or piles, with the year the bark was peeled, and then utilizing it before it is old enough to be in danger of attack. While it is a common practice for tanners and dealers to keep a record of the age for other reasons, the utilization of the bark within three years is by no means universal, as was demonstrated by the writer's investigation at one tannery, where $50,000 to $75,000 worth of old hemlock bark was found to have been rendered almost worthless, while the remainder of the bark in the yards, which was less than three years old, showed no damage whatever.

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THE NATIONAL FORESTS AND THE FARMER.

BY

HENRY S. GRAVES,
Forester.

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THE NATIONAL FORESTS AND THE FARMER.

By HENRY S. GRAVES,
Forester and Chief of the Forest Service.

A FEW years ago more than a hundred farmers in the Kootenai Valley, in Montana, petitioned against the proposed elimination of their section from the Kootenai National Forest. They wanted it to remain where it was. Its elimination they knew, from the history of adjacent land outside the Forest, would mean that it would at once be taken up by timber speculators and lumber companies, to be held for years without development. They knew also that if this came about neighbors could not be secured nor roads and schools be developed in the county anything like as rapidly as if the land remained in the Forest, where those portions better suited for agriculture than for forest purposes could be entered by permanent settlers under the forest homestead act.

In 1911 an association of farmers in Colorado, who draw upon the North Platte River for water to irrigate their farms, sent an urgent request to the Government to restrict timber cutting on the North Platte watershed, so that as far as possible high spring freshets might be prevented and more water furnished during the summer months, when their crops were most in need of it. They relied upon the National Forest which included that watershed to insure them a steady flow of water in the stream, on which their crops depended.

These two instances, taken at random from a great number of similar ones, indicate the interest which farmers take both in the existence of the National Forests and in the way they are administered. This interest does not belong only to farmers in and near the Forests; it belongs to farmers everywhere. The examples cited illustrate but two of the many ways in which the National Forests influence the welfare and development of agricultural communities, an influence which extends far beyond the Forest boundaries. For one thing, the National Forests are the American farmer's most valuable source of wood, the chief building

material for rural purposes. For another, they are his most valuable source of water, both for irrigation, as just indicated, and also for domestic use. Scarcely less important, they afford him a protected range for his stock; they are his best insurance against damage by floods to his fields, his buildings, his bridges, and his roads, and against decreasing soil fertility.

Geographically, the National Forests cover a wide area. They comprise the higher portions of the Rocky Mountain Ranges, the Cascades, the Pacific Coast Ranges, a portion of the forested coast of Alaska, some of the mountain and hilly regions in eastern Montana and in the Dakotas, Oklahoma, and Arkansas, and limited areas in Minnesota, Michigan, and Florida. Besides these, land is now being purchased for National Forests in the White Mountains of New Hampshire and in the Southern Appalachians. In regions so vast and widely scattered the conditions of agriculture, and forest conditions too, necessarily vary in a great degree, which brings about corresponding differences in the way the National Forests affect agricultural interests and the extent of their influence. But wherever agriculture can be practiced the farmer is benefited by the existence of National Forests and their proper handling.

Experience has amply proved that in regions where timber is the most important natural resource permanent forests managed with a view to sustained timber production are not only beneficial to the farmer but absolutely essential to the continuance of agriculture. If the timber is exploited without thought of the future, lumbering presently comes to an end. The result is that the local market for farm products furnished by the presence of lumbering operations is withdrawn. Forest fires ravage the cut-over lands and in the end destroy all prospects for further lumbering. What should be productive timberland is converted into a waste. From such a region the farmers who may have established themselves on scattered areas of land suitable for agriculture move out. In some parts of Europe it has been found necessary, as a preventive of distress to the agricultural population and of abandonment of farm lands, to modify the cutting plans laid down for the forests in order to provide for greater continuity of operations. There

are parts of the United States in which cultivation of the soil has ended with the local lumbering, or shortly afterwards. The farmers have found that without the market for their meats, vegetables, hay, and grain which the lumbermen supplied they can not make a living. There are other regions where the stability of the agricultural industry is absolutely bound up with forest protection. This is strikingly true in parts of the Appalachian Mountains. It is no less true in many of the National Forest regions in the West.

FARMS IN THE NATIONAL FORESTS.

In general, the National Forests occupy the higher and more rugged portions of the mountains, at elevations above the main agricultural zone. Their permanent boundaries are drawn in such a way as to exclude all large bodies of agricultural land; the lands included in the National Forests are those chiefly valuable for forest purposes. In many instances, however, there are within the Forest boundaries scattered patches and strips of land of agricultural character, but too small to be eliminated from the Forest by themselves. These lands occur along some of the valley bottoms, at the confluence of streams, and on narrow benches. Whenever such tracts are suitable for the development of agricultural homes they are opened to entry. Thus the establishment of a National Forest does not mean that agriculture within its boundaries is prohibited. On the contrary, the Department of Agriculture is classifying the lands in the Forests in order to search out the agricultural areas and to bring about their development as fast as possible. To show how the classification of forest and agricultural lands works out in putting every acre or parcel of land within the National Forests to its best use, the Kootenai Valley may be taken as an example. Here a large river winds for 150 miles through a National Forest. It is distinctly a mountain stream. At many points steep, densely wooded hills drop down to the water's edge, making the valley a gorge or canyon. Where tributary streams join the main river, narrow V-shaped valleys run up them for short distances, narrowing in width as the mountains close in. Here and there bars in the river have resulted in a deposit of silt to form long and narrow fertile bottoms, or

level silt islands have been thrown up in the stream itself. Part way up on the mountain slopes occasional level benches afford a few acres or a farm or two of fertile land. At first it was proposed to throw out the entire valley, a strip 3 miles in width on either side of the river. Ninety-five per cent of this belt, however, is nonagricultural land, whose cultivation should not be attempted. It can be of most use to the local community, as well as to the country at large, by growing timber. So instead of throwing the whole valley out of the National Forest, the Forest Service has painstakingly surveyed every little river bottom, island, or bench which contains enough arable land to support a home. Many of these patches are small, but their soil is so fertile that a home can be maintained upon them by intensive truck or orchard farming. Much of the valley is not yet covered by the rectangular system of public land surveys, and instead of waiting for them the Forest Service has, by metes and bounds, run out the boundaries of each of these farmsteads, segregating them from the Forest and making them available for settlers. In this fashion more than 300 farms have been carved out of the Kootenai Valley. The rest of the land has been kept under Government control for continuous forest production, the economic function which it should fulfill.

Another illustration might be cited from Fortine Creek, in the western portion of the Blackfeet National Forest, in northern Montana. Here conditions are somewhat different from those in the Kootenai Valley. Two high, rugged mountain ranges, one on the north along the Canadian border and one on the south, form a divide from the Flathead drainage. Between them lies a broad, level valley, not unlike many of the lower valleys in the Allegheny region. In places it is 3 miles or more in width, offering almost unbroken stretches of arable land. Here and there along its edges spurs jut out from the mountains, forming an irregular boundary with little fingers of cultivable land running up the channels of many of the small mountain streams. The problem here is not alone to determine the most valuable use for each acre of land. Outlets must be retained for the large bodies of timber back in the mountains, and mill sites for manufacturing this timber must be available. In a word, a practical boundary line must be fixed which will set off the

forest areas, together with the necessary facilities for utilization, from the arable lands to be turned over to the farmer. This is precisely what the Forest Service is doing, and in this way the greatest permanent usefulness of each resource as an economic asset of the country is secured.

The fact that a farm is within the boundary of a Forest does not operate to hinder the owner in developing his property. Actually he receives many direct benefits and privileges from the fact that his farm is there. In some places farm values are higher because the land is in a Forest. Settlers are seeking such farms in order to get the advantages of protection of stock and other privileges, and it is very common, as cited at the beginning of this article, for farming communities inside the Forests to protest against proposed eliminations that would put them outside the boundaries.

Many thousands of farms are now being developed within the boundaries of the Forests. This does not include those occupying the wider valleys which extend into the Forests and which have been segregated by elimination, but only the individual farms and small groups which could not in practice be eliminated without including large areas of nonagricultural timberland. During the last decade the Forest Service has classified as agricultural and opened to entry over 15,500 individual scattered tracts in the Forests, covering over 1,700,000 acres. The classification has resulted further in lessening the area held in the Forests by over 9,000,000 acres, through eliminations, which enable the unappropriated and unreserved agricultural land to be taken up under the general homestead laws. Within the last two years there has been eliminated in large blocks 2,650,426 acres. Not all of this land was agricultural, but these areas and the 1,763,867 acres under consideration for elimination contain the bulk of the agricultural lands originally included in the Forests. The remaining agricultural land is chiefly confined to isolated tracts scattered here and there; to restricted areas requiring irrigation, but where water can not be developed; and to certain river bottoms and benches which are now covered with very heavy and valuable timber.

The scattered patches and strips of agricultural land will be opened to entry as fast as classified. The best of such tracts have in most cases been taken up. What remain are

as a rule not only isolated, but so high up that the seasons are short and farming is not as good as upon hundreds of thousands of acres of vacant land on the public domain outside the Forests. Where the area is too small to constitute a practical farm unit, the small cultivable strips or patches are not opened for homesteading but are retained for forest purposes. A real injury is done the homeseeker who is induced to settle upon a tract of land so small and unproductive that his only escape from poverty is to abandon it. That very land, however, may be valuable for forest purposes, and an attempt to use it as a farm is an economic error for the reason that existing wealth is destroyed and no new wealth created. The aim in administering the National Forests is to establish permanent farm homes and communities of homes. Where the land can not be developed for agriculture but can be used for timber development or some other industrial purpose, it should be devoted to what will bring the greatest service to the localities and the country as a whole.

There is also a certain amount of land in the Forests which ultimately can be farmed, but which at the present time is covered with very heavy timber. A constant pressure is brought on the Government by private individuals who want to acquire possession of these lands primarily for their timber value. Single tracts of 160 acres often have a value for the timber alone of $20,000. So it is inevitable that here and there individuals are willing to use almost any means to get possession of such a timber stake for nothing or next to nothing. But in spite of the fact that some of these lands have soil of an agricultural character, to throw them open for homestead purposes would not result in farm development. This has been proved over and over again where lands acquired in this way under the guise of the homestead law are to-day in the hands of lumber companies who promptly purchased them from the settlers as soon as title passed, and are either reserving them for later cutting or are holding the land itself after cutting for from $40 to $60 an acre, or even more—a speculative process which effectively prevents the possibility of men of small means acquiring and establishing homes there.

Thus agricultural development is retarded by the speculator capitalizing the unearned increment and passing it on

as a perpetual burden on the land. Removing the timber through its sale by the Government before the land is opened to settlement removes the speculator and makes it reasonably certain that the land will be taken by a permanent settler and that the unearned increment will go into clearing and productive farm development.

It is not meant to imply, of course, that most applicants for a timbered tract fail to show good faith. Without question, many really desire the land primarily for the agricultural value, and start with the idea of clearing it, even if the timber has to be cut and burned. The fact remains, however, that in most cases the settler sells out and goes elsewhere. When it costs from $100 to $250 per acre to clear land and requires a long time and the most arduous effort to get a tract under cultivation, while it is possible to sell that same tract for its timber at from $2,000 to $10,000, or even more, the average settler prefers to realize on the timber and move to another place where the difficulties of farming are less severe.

The Government is withholding from agricultural entry such heavily timbered land until after the timber is cut off. But as soon as this is done the land is opened to entry and settlers acquire it directly from the Government for free homesteading, instead of having to pay from $40 to $60 an acre to speculative holders. This procedure is being successfully carried out in many places to-day. For example, in the Kaniksu National Forest, in Idaho and Washington, timber sales have been made to include much of the remaining agricultural timbered land. Within eight years fully 10,000 acres of land will be made available for settlement. Permanent homes will be established and there will be available for the use of the communities approximately $225,000 for roads and schools, their share of the proceeds from the sale of the timber. In the Kootenai Forest, in Montana, the Government is disposing of the timber in a way to open up the remaining acres of agricultural land in the Kootenai Valley lying within the Forest. Directly adjacent to this Government land are thousands of acres of timbered lands taken up under the homestead law before the Forests were established, and now held by timbermen and speculators without development of any kind. It is private ownership

of heavily timbered agricultural land that blocks farming development; Government ownership insures such development under conditions that give opportunities to the small settler whose only capital is his strength and courageous perseverance.

There are still some lands in the Forests which have soil suitable for cultivation if water were available for irrigation. Where water can be secured such land is promptly opened to entry. In case water can not be developed the land is retained in the Forest and used for tree growth and grazing.

One of the most serious agricultural problems of the Northwest to-day is the development of the logged-off lands in private ownership. In Oregon and Washington alone over 3,000,000 acres of such logged-off lands are lying idle, though much of the area has fine agricultural soil and a climate to insure abundant crops and the development of thriving farming communities. Yet in this same region hundreds of settlers are seeking to find some place in the National Forests, usually remote from transportation, high in the mountains, where the climate is harsh and soil relatively inferior, because the good lands at lower elevations outside the Forests are held at prohibitive prices. The real solution of the problem of agriculture in such sections is to develop the rich logged-off private lands that lie outside the Forests and are now idle and unproductive, not to throw open the nonagricultural Forest lands as some are urging.

SPECIAL BENEFITS TO THE FARMER.

Specifically, the benefits to the farmer from the existence of National Forests may be discussed under the following heads:

(*a*) The benefits through protection of water resources.

(*b*) The benefits through supplies of Forest products.

(*c*) The benefits from grazing privileges.

(*d*) The benefits, direct and indirect, from the establishment and maintenance of various industries utilizing the resources of the Forests.

(*e*) The benefits from public improvements built by the Government.

WATER RESOURCES.

One of the purposes underlying the establishment and maintenance of the National Forests is the protection of the sources of water supply. By their situation in the mountains the Forests cover the higher and more rugged portions of the watersheds at the headwaters of various rivers and streams. The protective influence of the forest cover on sources of water supply is of importance to all industries using water from the streams rising in the National Forests. It is of special importance to the agricultural interests. In many parts of the West the water used in irrigation is derived almost entirely from streams which have their source in the National Forests. This is true of the majority of the great reclamation projects of the Government, which furnish water for many hundreds of thousands of acres of land. Every farmer who uses this water is, in a measure, directly dependent in the long run on the proper handling of these National Forests. In several instances National Forests are maintained primarily for the purpose of watershed protection. The headwaters of the Salt and Verde Rivers in Arizona, on which is one of the greatest of the Federal reclamation projects, are comprised in the Tonto and Prescott National Forests. Considerable portions of these watersheds are administered as National Forests in order to control the grazing and so to prevent erosion. Every water user on this project realizes that overgrazing of the watershed would greatly hasten the silting up of the reservoirs and canals.

On many National Forests in the Rocky Mountains and elsewhere, protection belts of forest have been established on the upper sources of important streams. In these belts all cutting will be very carefully regulated, so as to run no risk of disturbing the forest cover, which exerts a beneficial influence in holding snow and storing water during the period of heavy precipitation. Often no cutting at all is permitted, except of dead timber. In the steep mountain ranges of southern California the use of the pine forests high up on the watersheds is absolutely controlled by the necessity for conserving the water needed to irrigate the citrus-fruit farms in the valleys below. Except where it is very clear that

heavier logging will have no harmful effects upon stream flow, cutting is confined to the removal of an occasional overmature tree whose usefulness as a conserver of water is practically gone. Often Forest officers cooperate with local water users in studying conditions of stream flow and determining how they should affect the management of the Forests. In Colorado committees representing irrigation associations have been conducted over timber sales on watersheds in National Forests, the methods of cutting explained to them, and conferences held to determine how far the Government may safely go in utilizing the timber. All told, the value of the farms whose water supply for irrigation is protected by the National Forests will run into the hundreds of millions of dollars.

Farmers and other water users are very jealous of the way in which the Forests are handled. On the Angeles Forest alone local citizens contribute over $15,000 a year to aid in building fire lines for the prevention of disastrous forest and brush fires. Such men see in the right handling of the Forest the source of their own prosperity, and they cooperate in every way they can to aid the Government in its forest work.

A second way in which farmers are affected by the National Forests is in the use of water for domestic purposes. Not only do individual farmers get the water used in their homes and for their stock from streams rising in the Forests, but many small towns and communities are thus supplied. Altogether about 1,200 towns and cities depend on National Forest water. With the increased development of the country which is following the utilization of the National Forest resources, the number of communities dependent on water from the Forests is increasing, and constantly larger quantities are used in each locality. In the planting operations on the National Forests special attention is given to watersheds which supply municipalities and rural communities. From 10,000,000 to 15,000,000 little pines, firs, and spruces are planted every year in the Forests, and some tons of tree seed sown. Not only is the forest cover on these watersheds being extended by the Government with the aid of local citizens, but special arrangements are made for controlling grazing and other uses of the area in order to prevent the silting of the stream or pollution of its water.

FIG. 1.—A FARM IN THE IDAHO NATIONAL FOREST, TAKEN UP UNDER THE ACT OF JUNE 11, 1906.

FIG. 2.—A SMALL BUNCH OF CATTLE GRAZING IN AN OPEN YELLOW PINE STAND ON THE DURANGO NATIONAL FOREST, COLO.

[Of the 29,000 grazing permits issued annually on the forests, 24,000 are for small owners of stock.]

AN "AGRICULTURAL" CLAIM ON THE ST. JOE NATIONAL FOREST.

[The 60° slopes rise directly from the creek. There is practically no level land on this claim, but the white pine timber is valued at $20,000.]

ANOTHER "AGRICULTURAL" CLAIM ON THE ST. JOE NATIONAL FOREST.

[The ground is so steep that both hands have to be used to keep from sliding off into the creek. The photograph was taken on May 22, but snow was still on the ground. The applicant claimed that this was excellent wheat land.]

FIG. 1.—IMPORTANT IRRIGATING DITCH AND LATERAL LESS THAN ONE MILE FROM BUSINESS SECTION OF EPHRAIM CITY, UTAH, BADLY DAMAGED BY THE FLOOD OF AUGUST 24, 1912.

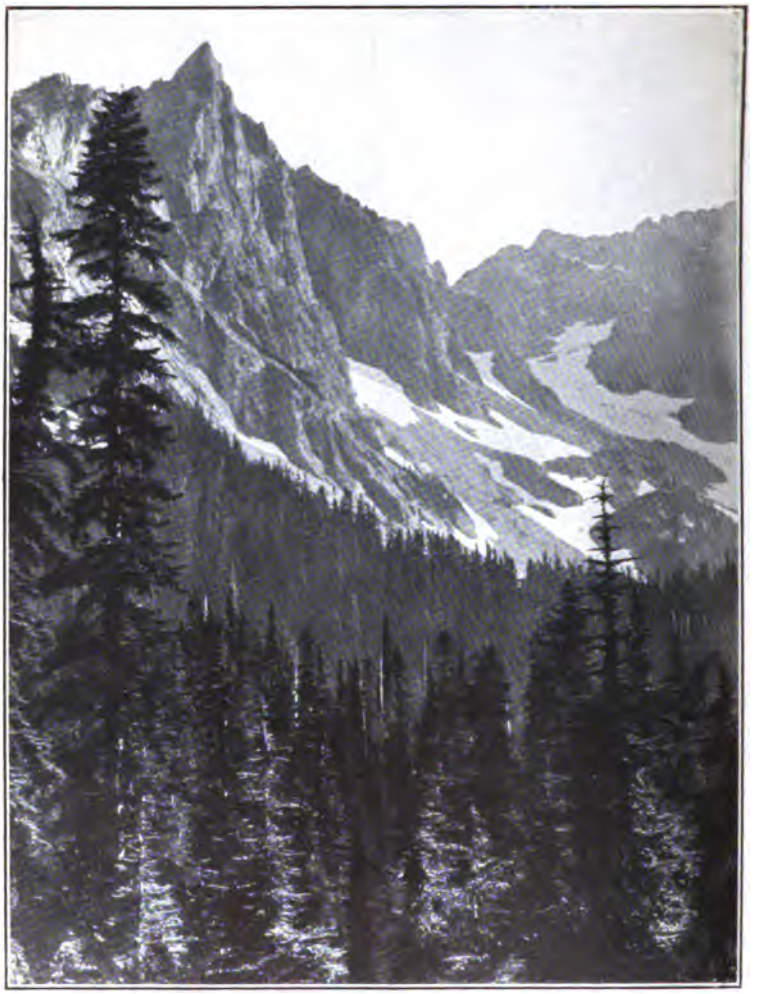
[The flood overflowed the cribbing above man on left, lowered the creek bed 5 feet, and washed out the headgate.]

FIG. 2.—A STREAM IN A NATIONAL FOREST WHOSE HEADWATERS ARE PROTECTED.

[Quosatena Creek as it enters Rogue River, Siskiyou National Forest, Oreg.]

A SMALL TIMBER SALE AREA IN AN ENGELMANN SPRUCE STAND ON THE MADISON NATIONAL FOREST, MONT.

[Farmers and other local residents may purchase timber from the Forests for the actual cost of making the sale, and the number of such sales is steadily increasing from year to year.]



A REGION FOR THE MOUNTAIN CLIMBER, CAMPER, AND SPORTSMAN.

[In the Cascades, Snoqualmie National Forest, Wash., sometimes called the "Alps of the United States." The mountains here are very high and rugged, with peaks rising over 11,000 feet. The great Douglas fir stands on the west slopes are the most heavily timbered forests in the country.]

One of the greatest handicaps which the Forest Service has already encountered in meeting this problem of guaranteeing pure water for domestic use is the fact that certain portions of the watersheds have already been privately acquired and the control thus passed from public to private hands. Every year petitions are received for additions to the National Forests, in order to include under the protective system some town or community watershed.

SOIL WASHING AND FLOODS.

Of no less importance to the farmer and the community is the need for having the water supply under constant control and free from torrents which carry away diversion dams, headgates, bridges, and roads, and leave irrigation ditches, fields, and streets strewn with bowlders and mud. Such floods are a matter of disastrous experience in a number of mountain valleys where successful agriculture depends upon unfailing streams. In the San Pete and Castle Valleys of Utah alone the damage to cultivated fields, irrigation works, roads, water-supply systems, and power systems, as the result of erosion and floods since 1890, may be conservatively estimated as totaling in six figures.

When these valleys were settled the streams flowing into them were clear even during the high-water season. As settlement grew the increasing number of cattle and sheep were forced back to the headwaters of the streams for summer pasturage and the timber for domestic supply was cut where it could be secured most conveniently without thought of future protection. The herbaceous and shrub vegetation on the high untimbered slopes, which formerly broke the force of the rain, bound the soil together in its resistance to the combined force of water and gravity, and kept it sponge-like through the constant addition of vegetable matter, was reduced or destroyed by overstocking and premature grazing with cattle and sheep. At the same time the originally mellow soil became packed beneath, and a dust bed on top. The transformation brought about a change similar to the difference between a cultivated field and an adjoining barnyard, the former highly receptive to falling rain, the latter almost impervious. Small gullies soon formed; these increased in number and size, widening out into fan-shaped

drainage at the headwaters of streams and collecting as a funnel in the canyon below. The character of the run-off under such conditions of the watershed is illustrated by an observation in the San Pete Mountains of Utah. At 11 a. m., July 30, 1912, a light rain started; at 11.45 a. m., the roar of a flood was heard at the head of a small canyon draining approximately 1,500 acres of sparsely timbered land at 10,000 feet elevation, lying fan-shape at the head of the canyon. The natural stream, a mere driblet, was increased to a maximum front 25 feet wide and 8 feet high. The main flow lasted approximately an hour and in this time changed its course at the mouth three times. A solid section of bank approximating 5,000 cubic feet was torn out in a few minutes. It is estimated that 30,000 cubic feet of gravel and bowlders came down in this flood resulting from 0.5 inch of rain in 2 hours over a drainage area of 1,500 acres which was hard packed and gullied.

A flood of this character originating at the headwaters of a single canyon on August 24, 1913, carried bowlders as large as 10 cubic feet to the settlement beyond the canyon; headgates were washed out and the main ditch was lowered at one point 5 feet below the intake of laterals, and at another point the channel was filled up and changed. Basements, sidewalks, lawns, and corrals were left under a sheet of mud; the city light plant and the water system were temporarily impaired, and 7 miles of a much-used timber wagon road was made impassable.

To eliminate such floods it is essential to eliminate the conditions which give rise to them. With the watersheds under protection, grazing is adjusted to give nature a chance to revegetate the untimbered slopes; timber cutting is so planned as to protect areas of critical position against erosion and floods; and investigations are under way to develop feasible methods of repairing damage where erosion has progressed to a degree beyond repair by nature alone. By proper management it is believed that this repair work can be done in time without interfering materially with the farmers' need for timber and range. The Government is thus working to protect the farms from disasters that in a few hours might wipe out the results of many years' hard work.

Fully as important, but less noticeable, is the protection afforded both local and general soil fertility by the National Forests on our principal mountain ranges. The pioneer found rich soil on both hillside and plain; but experience has taught him, and the soil expert has demonstrated, that while the fertility of the valley is permanent, the fertility of the hillside is transitory. The humus produced by forest growth makes an exceedingly rich soil, but rainfall and gravitation constantly tend to carry that fertility to lower lands. So long as the slopes are well protected by tree growth, they continue to add to the fertility of the valley lands. Each year a ton or more of litter is added to each acre of forest soil in a dense forest, but the soil fertility remains practically constant, the increase being slowly contributed to lower lands through the forces of nature. The hillside lands are slowly lowered, while those of the valley are raised. So long as this continues at an imperceptible rate the valley is benefited, while the hills are not injured. An analysis of Illinois soils showed that on hill land the surface 7 inches of soil contained an average of 2,000 pounds of nitrogen, while the next 7 inches contained only one-third as much, and the next still less. At the same time the valley land contained in many instances three times as much, and was fairly uniform to a considerable depth. Under normal forest conditions the more valuable elements are slowly transported from forest to field. Cut off the forest, and the hillsides become a source of sterility instead of fertility. The unregulated rush of waters carries sand and gravel instead of valuable plant food down into the field, destroying the soil fertility of both hillside and valley. This wholesale soil waste and destruction is prevented by the regulated cutting of timber and restricted grazing in the National Forests. The continuation of this protection is all that stands as a safeguard against great injury to the soil fertility of millions of acres of very valuable and productive farm land.

PROPER CONTROL OF TIMBER RESOURCES.

One of the immediate benefits to the farmer comes through the public control of the timber resources. In the first place, settlers who live in and adjacent to the Forests are granted free use of firewood and certain other material for

domestic purposes, and through a recent enactment of Congress there is now authority for such settlers to secure larger amounts of timber needed on their farms merely by paying the Government what it actually costs to administer the sale. This ordinarily is from 50 to 75 cents per thousand feet, which means an actual saving in money to the farmer of from 50 cents to $5 per thousand, according to the class of timber. In administering the National Forests, provision is made first of all for the needs of the farmers and other local residents. There is thus a guarantee of a permanent supply of material for local communities. The importance of this is illustrated in those regions where the National Forests constitute practically the only source of wood and timber. In certain places in the Southwest and in other places east of the Rocky Mountains, farmers sometimes travel 100 miles to a National Forest to obtain firewood.

Many National Forests in sparsely timbered regions serve as community woodlots for the farmers surrounding them. Instead of cutting material for fuel and farm improvements from the woods on his place, like the average farmer east of the Mississippi, the ranchers turn to these public woodlots. The Sioux National Forest, on the Dakota-Montana line, supplies from 1,200 to 1,500 farmers. The Wichita National Forest, in western Oklahoma, furnishes material to between 1,400 and 1,500 more, and the Cache and Minidoka National Forests, in southern Idaho, together each year furnish farm materials to 3,400 permittees. This use covers every conceivable requirement of the farm—cordwood, fence posts, derrick poles for stacking hay, corral poles and barn rafters, and lumber for buildings. Where timber is particularly scarce these forest woodlots are reserved entirely for the needs of localities surrounding them, including mining industries, where they occur, and local towns as well as rural farm communities. Sales of timber for shipment to outside regions are only permitted where there is clearly more timber than local users require.

Often the community feature of a National Forest is further emphasized by cooperative sawmills constructed and run by groups of farmers or small communities to supply their needs as a whole. Several small mills of this character are in successful operation on the National Forests in the

great farming region of central Utah. The farmers who own them go up into the mountains with their teams for a month or more after the harvesting season, cut and haul logs to the mill, saw the logs into lumber, and haul the latter down to their farms for the next year's use. Opportunity is thus afforded to keep the farms in the vicinity of the National Forests supplied with wood for all purposes at a very slight cost, aside from the time of men and use of teams when ordinary farm work is slack. Not infrequently one finds timber cuttings in progress on the National Forests which are meant to supply the specialized industries of a region. Small mills in the Sierras, for example, are manufacturing National Forest timber into trays which are used in enormous quantities in the raisin belt and citrus-orchard districts of California. Other purchasers of timber from the Government are engaged in cutting fence posts in large quantities for the supply of farming communities, where the individual ranchers can not themselves go to the mountains to procure such material.

The free-use privilege was taken advantage of during the past year by over 34,000 persons, who obtained material entirely without charge aggregating 120,500,000 board feet and with a total real value of $183,000. Through these privileges and through the public control of the timber, local communities at a distance from the general lumber markets are protected from the excessive prices which frequently obtain where the small man is unable to protect himself on account of the control of supplies by private individuals.

GRAZING.

One of the greatest benefits of the National Forests to the farmers is the protected range which is given to them for their stock. On about two-thirds of the area of the Forests there is more or less forage. Like other resources this is put to use, and more than 9,400,000 cattle, sheep, horses, swine, and goats graze on the Forest range. The grazing is under Government regulation, so that the forests are not injured and at the same time the ranges are not overstocked.

Every farmer is to a certain extent a stockman. When his farm is remote from markets it is the live stock which yields him his income. This is especially true of the farms

in and near the National Forests, most of which are at considerable distances from centers of population and where the transportation facilities are still very poor. If the farmer can secure suitable grazing grounds upon which his stock may remain during the summer, a period averaging throughout the West about five months, he is thereby relieved of the care and expense of maintaining them upon his own land, and the feed they would otherwise have eaten during the summer is accumulated for winter use. It is precisely at this point that the National Forests serve to meet his special needs, for the farmer is given preference in use of the forage on the Forests. Every man is allowed to graze 10 milch and work animals entirely free of charge. He is then preferred before all others in further grazing privileges, for which he pays a very moderate fee. The regulation of the use of the ranges gives him protection, so that he is sure of having enough forage to carry his stock through the summer. Prior to the creation of the various National Forests the small live-stock owner was practically prohibited from utilizing the ranges adjacent to his lands because they were already stocked to their utmost capacity by larger owners. If in one year there was enough feed for the farmer's stock the next year some large outfit might sweep through and use it all. The small man could not afford to turn his few head loose among such large herds because of the danger of the animals straying to remote ranges.

As a concrete example of how the present Government policy has encouraged and built up the production of live stock by farmers, the Manti Forest, in the State of Utah, may be cited. This Forest lies between two very productive valleys in central Utah, where the demand for farms is so great that the farm unit is being reduced every year, the average for 1914 being 38 acres. When the Forest was created the ranges were practically monopolized by the large herds. Now the Forest range is occupied almost wholly by the stock of the farmers living in the near-by valleys. During the season of 1914, 1,259 permits were issued for the grazing of cattle and horses and 513 permits for the grazing of sheep upon this Forest. The ownership of these animals was divided as follows: Permits for 1 to 40 cattle, 1,185 owners; 41 to 100, 61 owners; above 100 cattle, 13; from 1 to 1,000

sheep, 506 owners; above 1,000, only 7. Several hundred cattle permits were for less than 10 head and dozens of the sheep permits for less than 75 head. The average number of sheep grazed per permit was 290 head, and the average number of cattle and horses was 15. This shows how the small owners are taken care of.

It will be seen to what an extent the farmers in the valley surrounding the Manti Forest depend upon it as an aid to their farming operations. Every year there are applications from new settlers who desire grazing privileges for from 1 to 10 head of cattle, and the larger owners are being continually reduced to make room for this class of permittees. These farmers turn their stock into the Forest in the early spring and return them to their farms in the fall, when those which are ready for market are sold, while the breeding stock is wintered upon the farm. It is an attested fact that stock sold from the Forest ranges weigh more and bring better prices per pound that the same class of stock from the open ranges outside the Forests. It is also true that these farmers could not successfully operate such small farm units without the aid of the Forest ranges. This is the sort of result that is being secured on all the National Forests where there is grazing land and near-by farms. Every year a larger number of permits are issued to small owners. In fact, out of 29,000 permits, 24,000 are for small men, chiefly farmers living in and near the Forests.

The development of the dry-farming principle, which is bringing under cultivation large areas of land hitherto believed to be incapable of producing agricultural crops, can be successfully carried through only by maintaining live stock to eat the rough forage crops which are produced upon the majority of such farms. If the dry farmer can depend upon obtaining range for part or all of his surplus stock within the neighboring Forests, he will be able to add very materially to the meat production of the nation and at the same time develop his land much more rapidly.

In many parts of the West the dairying industry is rapidly growing, and applications from settlers for range within the Forests upon which to graze their dairy cattle are being received in large numbers. To meet this situation certain areas have been reserved exclusively for this class of animals,

and drift fences have been erected to prevent the dairy cattle from mixing with the purely beef herds around them, and also from wandering from their own ranges. Already farms in and near the Forests bring a higher price in the market by reason of the grazing privileges which the farmer has for his stock.

BENEFITS FROM INDUSTRIAL DEVELOPMENT.

The Government is aiming to secure a development of all the various natural resources in the National Forests. This means the establishment of new industries of all kinds; it means, further, that the industries will be permanent ones, because the resources upon which they depend are being handled conservatively; it means the development of communities, towns, and even cities; it means more people working to create wealth and an increased demand for all the products of the farm. It means, therefore, for the farmer, a greatly increased market for his products. Every timber sale means development of the lumber industry, with the establishment of camps in the Forest to log out the timber and a sawmill established for its manufacture. There is developed immediately a market for all food products raised on the farm to supply the needs of the men employed in the work; there is also created a demand for grain and hay for the horses and mules used in the various lumbering operations. Very commonly a large timber sale means a railroad, either a main line or a branch line, and all extensive railroads built under National Forest contracts must be common carriers. In many instances this means not only that more people are brought into the farming communities, but that still greater markets become available by shipping over the railroad. Exactly the same process follows every substantial mining development.

There is one industrial development going on very rapidly in the National Forests which is often overlooked as an industry, and that is the development of the recreation resources. Throughout the National Forests there are a multitude of small lakes and streams and points of special scenic attraction. Many thousands of people are going every year into the National Forests for recreation purposes. Probably not less than 1½ million pleasure seekers

use the Forests in this way every year. The development of the recreation resources is being encouraged by the Government in every way possible. Not only are the points of special interest being protected from injury by forest fires or otherwise, but improvements in the way of roads and trails are very rapidly making these interesting areas available to the public. In consequence hotels and cottages are being built around the lakes and at other points, and summer communities are springing up in great numbers. Such a community establishes a market for produce from the neighboring farms.

THE FARMER AS A CAMPER.

In many sections the people making use of the Forests for recreation are the farmers who live in the hot valley at the foot of the mountains. Thus, for example, in California, when the fruit-canning season closes in the hot San Joaquin Valley, thousands of small farm owners load up a camp outfit on a wagon and start for the Sierra and Sequoia National Forests. Each takes his wife, children, and dogs, and while the family gain new health in the timber camp on the edge of some mountain meadow, the farmer cuts his year's supply of cedar fence posts, and shoots the two deer which the law allows him.

In addition to the farmers' direct benefit from all development in the National Forests through increased markets for their products, there is immediately created a demand for labor and for the use of teams and other equipment. The Forest Service goes to the local ranchers, as well as to the lumber camps, for much of its labor in building trails and other work. Many of the patrolmen are young ranchmen having homes in or near the Forests. Exactly the same market for labor follows the use of the resources.

In some localities farmers work at certain seasons of the year in the National Forests cutting timber for sale, just as the New England farmer puts in time in the winter, when he has no other work for himself and his teams, getting out material from his own woodlot. The advantage to the farmer of being able to employ his time in off seasons profitably is self-evident. Where a local market exists the farmer can go into the National Forests, make a purchase of timber

on the stump at a reasonable price, and go to work. This is already a very valuable opportunity for many western settlers. The Forest officers prescribe methods of cutting which insure the maintenance of the forests and prevent unnecessary waste. As the country about the Forest becomes more fully populated the value of the opportunity thus afforded will increase. The farmer has his timber supplies taken care of by the Government without cost to him, and in consequence is often better off than the eastern farmer who must pay taxes on his woodlot, perhaps at an excessive valuation. Of the over 8,000 small commercial timber sales involving amounts worth $500 or less, made by the Forest Service each year, a large proportion are made to farmers, who, in connection with their ranches, run wood yards, small sawmills, and local lumber yards, or who distribute fence posts to a considerable agricultural district. Upward of 200 small sales are made annually in the vicinity of Butte, Mont., chiefly to farmers who cut and haul cordwood, mining stulls, mine props, mine lagging, converter poles, and the like from the Forests to supply the mining market of that region. Elsewhere many small timber contracts are let to farmers who cut a few thousand railroad ties each winter for delivery to some local line. Other farmers take out telephone poles in small lots, shingle bolts to be sold to some local mill, or small quantities of saw timber which are sold to local manufacturers. One of the interesting results of the establishment of National Forests in the Southern Appalachians is to bring employment to many of the people living in the mountains—employment not only in public works, but also through taking small contracts in cutting and hauling logs, piling, acid wood, and fuel. Such opportunities are often a stimulus to an entire community.

PUBLIC IMPROVEMENTS.

One of the farmer's first needs is adequate transportation. Millions of acres of farm land are to-day undeveloped because of the lack of good roads. In opening a new country, road building constitutes a hard problem for the settlers. At first their number is small; every man is struggling to erect his home and farm buildings and to clear the land; during the period of actually establishing the farm there is little or no

income from it, and usually the settlers can not afford to pay high taxes. Under such circumstances the burden of road building is so great that development is slow, and in thousands of cases the settlers give it up entirely and abandon their homesteads. The National Forests comprise the remotest and least settled localities. In many cases farming in these regions is still pioneer work, under as difficult conditions as ever existed anywhere in this country. Near the Forests are very large areas of excellent agricultural lands lying idle, lands capable of supporting many thousands of families and adding greatly to the food supply of the regions. One reason for the failure to develop this land has already been mentioned, namely, the excessive speculative prices at which it is held. That is a problem that will have to be met in large part by the communities themselves, which have the power of taxation. But one great reason also why a good deal of this land lies idle is the lack of roads. Every reason exists why the public should aid in this matter, because it is of vital importance to the public to have these lands put to productive use.

This problem is being met in two ways: First, by the work of public improvements being carried on by the Government in the Forests, and, second, by the direct contribution to the counties from a share in the receipts from the Forests. Every year the Government builds in the Forest roads, trails, bridges, telephone lines, and other improvements. The National Forests have been under administration only a decade, yet there have been already constructed 2,300 miles of roads, 21,000 miles of trails, 583 bridges, and 18,000 miles of telephone lines. Every one of these improvements benefits some settlers and ranchers. Many are the communities made accessible through the roads, bridges, and trails; many the ranchers who have been brought into profitable and pleasant communication with neighbors and outside places by the Forest Service telephones. Naturally the chief benefit of these improvements is to those who live within the boundaries of the Forests.

A direct contribution to the communities for roads and schools without reference to the Forest lines is provided for by Congress. There is appropriated annually for the use of the counties in which Forests lie 25 per cent of all gross

receipts earned from the sale of timber and from other resources, this to be used in road building and for schools. Where the resources of the Forests are marketable, the returns from this source are already very considerable. In the aggregate, nearly $900,000 is obtained in this way each year from the National Forest receipts, to be used locally in public improvements and schools. Some of the individual Forests are bringing in over $100,000 a year, and the business throughout the Forests is increasing so that the direct contribution to community upbuilding will soon be a very large one.

But in many of the Forests the resources are inaccessible and the greatest resource, the timber, is not salable under present conditions, except in small quantities. Under such circumstances the development of the Forest resources is slow, and there is but little direct return to the communities from Forest receipts. While ultimately these Forests will be of enormous importance to the country, the people need assistance now during the pioneer period of development. A great deal of the land in the counties in which the most heavily timbered National Forests are located is still a practical wilderness. The very foundation of any development in such sections is the construction of roads and bridges, and this is in many places enormously expensive. The clearing of the land for farming, the building of the homes, the building of schools, churches, and public improvements in the towns, in addition to the road building, are the burdens of a small, struggling population.

In many cases the National Forests occupy from 20 to 60 per cent of the area of the counties and contain timber of vast amount. Is there any wonder that the people are protesting that the Forests, which are not subject to taxes and are not yielding much from timber sales, are not contributing as they should to the development of their communities? Often they use the phrase that the Forests are blocking development or that the resources are locked up. This is, of course, not true, because the resources are available for use. What is meant, and what is true, is that the Forests are not contributing as they should to development of the communities in the counties in which the Forests are located.

Various proposals have been made, from time to time, looking to a possible solution of this problem. The most common proposal has been to abolish the National Forests and distribute the land among private owners in order that it may be brought under taxation. To make clear the utterly destructive character of such a program would need only a review of the scandals that accompanied the operation of the land laws as they pertained to timber lands, prior to the establishment of the National Forests, and a review of the results of private ownership of large areas of forest land where there has been no public control or public participation in the protection and handling of them. The National Forests will be one of the greatest sources of local prosperity. Publicly owned, they will be protected from destruction and their resources will be available for continuous service in building up and permanently maintaining local industries. Above all, they serve the public and their benefits can be shared by the average man instead of serving to enrich a few who might be in a position to secure control of them. The problem must be worked out in a way which will meet the immediate needs of the communities, without breaking down the integrity of the National Forests and withdrawing from the local communities the great benefits which will increasingly be derived from them.

Just such a constructive solution of the present difficulties of the settlers in heavily timbered National Forest counties has been proposed by the Secretary of Agriculture in his recent annual report. Briefly, this new policy proposes that where existing resources justify it and the public need can be demonstrated, future receipts from the National Forests be anticipated and advances be made by Congress for the construction of roads, bridges, and other public works, these advances to be returned to the Treasury from the sums which later on will be received when the timber can be placed on the market to advantage. This new policy would apply exclusively in those counties where there is a considerable area of Forest land, and so located that the resources can not be marketed at the present time, but later will yield a large revenue. Such a policy would fully meet the local difficulties arising from the fact that the National Forests are not subject to taxation. It would make the

Forest resources immediately realizable for public improvements; it would accomplish a development not possible without public aid; it would stimulate agricultural development; it would relieve the now struggling communities from a burden of taxation they would otherwise have to assume if the development of many of the National Forests communities is to go forward as rapidly as it should; it would hasten the development of the National Forest resources and aid in their protection; in every way it would work to help the small man. With such a plan in operation there would be removed the one barrier that now in a few places prevents the farmer from enjoying immediately the benefit of the National Forests.

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THE OPPORTUNITIES IN FOREST PLANTING FOR THE FARMER.

By

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Assistant Chief of Operation, District 3, Forest Service.

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THE OPPORTUNITIES IN FOREST PLANTING FOR THE FARMER.

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THE FOREST AND THE FARM.

Forestry is but one of the forms of crop production included under agriculture. The woodlot is an integral part of the farm and an essential factor in its success. Forest planting is that part of forestry which seeks to restock and perpetuate desirable timber and to establish new forests on treeless areas, where they are needed for protective or other purposes. Forest planting should not be confused with tree planting or arboriculture, for these terms cover only the planting and care of trees chiefly for ornamental purposes, while forest planting indicates the planting of trees in stands of considerable size, in which forest conditions are sought.

In the farming districts of the East, where almost every farmer has preserved a small bit of the original forest, which he calls his woodlot, there is very general lack of appreciation of the necessity for utilizing these woodlots to the best advantage, and of the methods by which this may be accomplished. Much may be done by management, which consists largely in careful cutting that will keep the forest cover intact, and in removing dead and dying and inferior trees. Planting, however, is very generally needed in order to hasten the restocking of woodlots with valuable species. One of the fundamental principles of forestry is that the trees in a stand must be sufficiently close together to be mutually helpful; that is, that their crowns must form a continuous cover to shade the ground and the tree trunks, in order that side branches may be self-pruned and the trees be forced into straight upward growth. Where there are open spaces they should be planted, and where it is desirable to cut a portion of a woodlot clean much time can be saved by planting instead of waiting for natural reproduction. On many farms the tract now occupied by the woodlot would be more valuable for crops, while on the same farm there may be an irregular plat of land or a piece of worn-out or rocky land upon which it would be wise to plant trees. Planting is also valuable to check erosion, or soil washing.

In general, forest planting in the United States needs to be modified, as shown on the accompanying map (fig. 17), according to an eastern, a central treeless, and a western region.

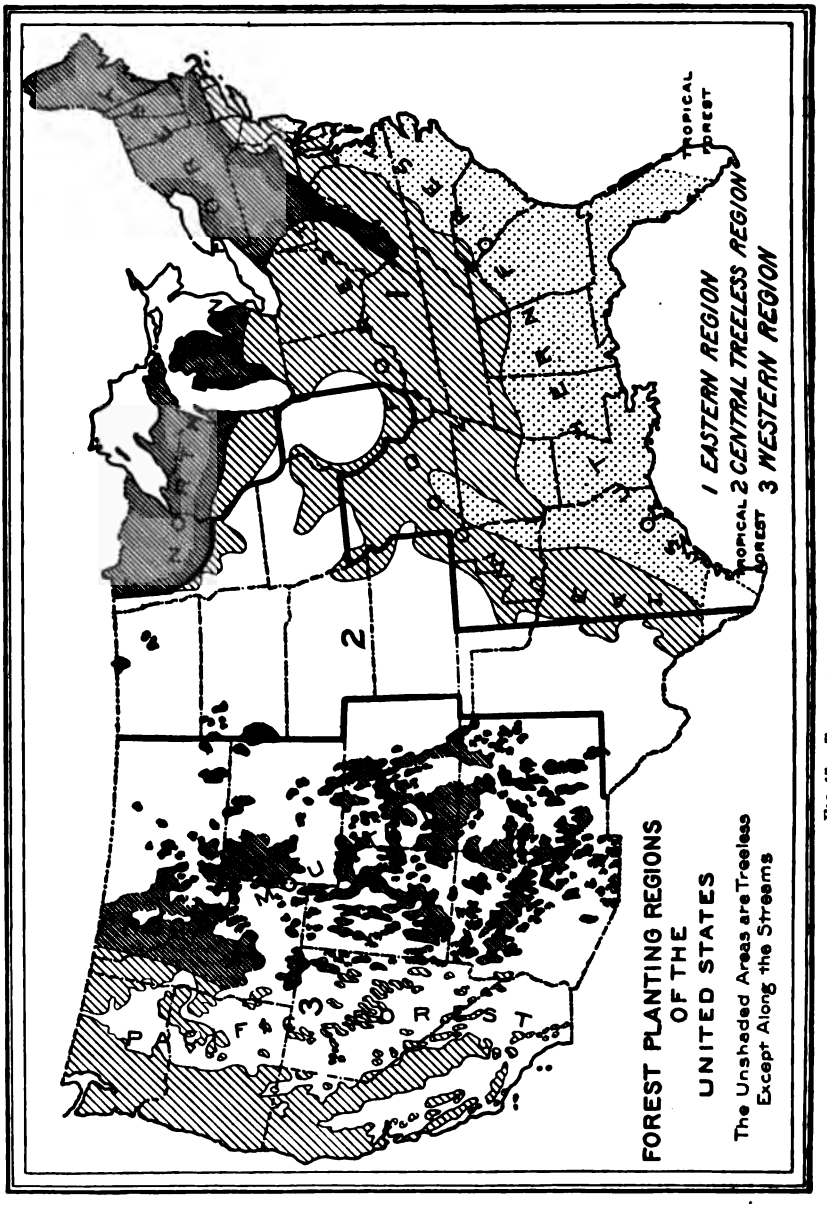
1 EASTERN REGION
2 CENTRAL TREELESS REGION
3 WESTERN REGION
TROPICAL FOREST
FOREST PLANTING REGIONS OF THE UNITED STATES
The Unshaded Areas are Treeless Except Along the Streams

FIG. 17.—Forest planting regions of the United States.

EASTERN REGION.

The eastern region includes all of the country east of the prairie States. This region in turn subdivides naturally into three parts, the northern spruce and pine forest, the southern pine forest, and the

big central hardwood belt. Of the two broad purposes of forest planting, commercial and protective, the first is most important throughout the eastern region, though in many localities protective planting is of chief interest to the farmer. Nearly 35,000,000 acres in the East should be planted. Of these 18,000,000 are in the northern States, 12,000,000 in the central hardwood region, and the rest in the Gulf and South Atlantic States.

The lands which offer opportunities for planting may be classified into (1) cut-over burned lands, not fitted for agriculture, which are not restocking naturally with commercially valuable species; (2) forest lands originally cleared for agriculture which have since proven unsuitable for this purpose; and (3) farm woodlots. Lands of the first class are for the most part owned by large corporations or by the States and do not greatly concern the farmer. They are chiefly in the northeastern and lake States, where extensive areas which once bore stands of spruce and pine have been so thoroughly denuded by ax and fire that no hope of natural restocking remains.

The abandoned farms of southern New England are striking examples of the second class, as are also the lands in the southern Appalachians, once cleared for farming but now ruined by erosion. Throughout the East farm woodlots have so deteriorated that planting is needed in order to restore them to their highest productive capacity; also on many farms there are tracts which are now lying idle or are being cultivated at a small return, but which would furnish splendid investments if devoted to tree growing.

The area of plantations already made in the eastern region is nearly 93,000 acres, and 85,000 acres of this are about equally divided between the northern tier of States and the central hardwood region.

Forest planting requires a considerable initial investment, and the cost is relatively higher than that required to start any other form of forest work. Therefore protection to the investment is of the utmost importance, and fire is the source of loss most to be guarded against. Other things that must be taken into consideration are cheap land, a good market, a minimum initial cost, and a low rate of taxation. The influence of each of these will vary with the locality and the purpose of planting; for instance, if a windbreak is needed to protect stock, crops, or farm buildings, then the rate of taxation, the market, and even the cost of planting will carry comparatively little weight.

NORTHERN FOREST.

Leaving out those planting problems which are of such magnitude that they must be handled by the State or by large companies, the farmer's part, in the northern forest, will be confined to the restocking of farm woodlots in the various agricultural districts and to the reforesting of abandoned farm lands in New England.

The New England landowner is realizing more and more the fact that although portions of his farm may be "run out" or too rocky to compete with the better agricultural land of the West in the production of annual crops, yet they offer a splendid opportunity for a very safe and satisfactory investment in timber growing, and wherever the farm includes sufficient good agricultural land to furnish the necessary annual income, the remainder should, by all means, be devoted to a forest crop.

Aside from extensive pitch pine plantations on the sandy areas of the Cape territory of Massachusetts and the islands of Marthas Vineyard and Nantucket, more than 90 per cent of the planting in New England has been with white pine. Other conifers which under suitable conditions have been successful are Norway spruce and European larch. Mature plantations of hardwood are comparatively rare.

The state governments of Connecticut, Massachusetts, and Vermont distributed about 1,500,000 seedlings in 1908, and these did not supply the demand. One private firm disposed of a million seedlings. Beginning with the spring of 1907, the state nursery of Vermont started in to distribute about 100,000 seedlings a year. Almost every farmer in Vermont may wisely do a certain amount of planting under the direction of the state officials. The most hopeful places for beginning the practice of forestry are the old, weedy back pastures which are now lying waste. Next in importance to these come the blank spaces in natural stands, which should be filled in.

White pine is considered the best, though red pine is of great value, especially for the drier soils, and the Vermont experiment station is using Scotch pine on dry sands. Norway spruce is of especial promise for the moist, strong land of the high mountain valleys—natural spruce land. Small plantations of black locust are being tried for supplying durable posts and stakes.

The conifers best adapted for planting, particularly on the sand plains, are Scotch pine, white pine, Norway pine, and pitch pine; and the hardwoods which promise best are chestnut, red oak, locust, and sugar maple. (See Pl. XXII, fig. 1.)

The increasing field for forest planting in the New England States is strikingly indicated by the recent increase in the area of unimproved land in farms. There was 11 per cent less improved farm land in Maine in 1900 than there was in 1890, and 20 per cent less in New Hampshire, with the other New England States between these two figures. In all, there are 2,500,000 acres in New England that need planting.

In New York State the species which are best adapted and which promise highest returns are white pine, red pine, Norway spruce, chestnut, red oak, basswood, tulip poplar, white ash, and, in moist places, Carolina poplar. Forest planting is increasing rapidly. The

work of the State in the Adirondacks is a remarkably fine example of good nursery practice and planting, and active steps are being taken by the state authorities to encourage forestry among the farmers and other landowners.

Pennsylvania divides readily into three sections where conditions of surface, soil, and climate are greatly enough differentiated to modify the practice of planting for each. The southeastern plain extends from tidewater along the Delaware westward and northeastward along the Blue Mountains, which form the northern boundary of Cumberland, Lebanon, Berks, Lehigh, and Northampton counties. The central mountains comprise a broad belt extending from the northeastern part of the State southwest to Maryland and West Virginia. The western hills include a section in the northwestern part of the State extending from the Allegheny River westward to the Ohio line and Lake Erie. The second-named region was covered originally with splendid forests of pine, hemlock, and hardwoods. There is relatively little need for planting in this region, so the greatest opportunities for farm forestry are in the other two sections.

The southeastern plain was an early settled farming region, and nearly every farm had its woodlot. Very few of these woodlots are now in good condition, though in some cases the owners have become interested in reforestation, and more or less tree planting has followed. The average prices of cordwood, fence posts, and farm repair material are higher in this than in any other portion of the State. This fact, coupled with the value of the land for agriculture, makes this region a splendid field for farm planting where quick-growing species will produce fence posts and other timber in a comparatively short time. Though more planting has been done in this section of the State than in any other, the early purposes of planting were rather vague. Two kinds of timber were planted. Of these white pine leads in the class of slow growers and black locust of the rapid growers. No great degree of success has been attained and the value of the early planting has been mainly educational. The great area of the near-by central mountain region, which is more valuable for trees than for any other crop, makes it desirable to devote woodlots on these plains to rapid-growing species. Those which seem to give the best promise are red oak, European larch, tulip poplar, and, where preservative treatment can be given, cottonwood, silver maple, white willow, loblolly pine, and pitch pine. Catalpa has proven successful enough to justify its limited use on rich soils, and with proper methods of growth it should prove a valuable post tree.

Where planting is needed in the central mountains the species used should be white pine and spruce, and hardwoods such as red and scarlet oaks, tulip poplar, white ash, and basswood.

The western hills section ranks next to the southeastern plains in agricultural value, yet contains a much larger proportion of land adapted to trees. Here planting will add to the general value both of the farm and forest areas. Since there are considerable areas of essentially nonagricultural land separating the agricultural sections, slower-growing species for the production of large timbers will be profitable, while, as on the southeastern plains, quick-growing species may be planted to advantage on many of the farms. Thus far, however, very little planting has been done. In the western hills the soil is admirably adapted to white pine, European larch, and hardwoods such as red, yellow, and scarlet oaks, white ash, basswood, honey locust, and rapid-growing species such as cottonwood, soft maple, and white willow, to be used in connection with preservatives.

In New Jersey forest planting is rapidly increasing. For timber production the species which have been chiefly planted are white pine, Scotch pine, white ash, and white elm, though species which give the best promise are the rapid-growing pines and spruces.

In the Lake States, which have a southern hardwood forest and a northern coniferous forest, forest planting is rapidly increasing. The principal species which have been planted are white pine, Scotch pine, Norway pine, European larch, and, to some extent, the more rapid growing hardwoods such as locust, catalpa, black walnut, cottonwood, ash, and elm. As in the East, woodlots are deteriorating and require interplanting. Excellent trees for this purpose are the white pine, the Scotch and Austrian pines, and the Norway spruce. The rapid-growing hardwoods which make such an excellent investment farther south can not be successfully grown in this northern region.

HARDWOOD FOREST.

In the States included within the great central hardwood forest region the sort of planting which should chiefly interest farmers will have for its object the utilization of waste land on the farm.

In those States which are making the most rapid general progress the state authorities are issuing publications that contain advice and information, are distributing stock from state nurseries, and are conducting forest work on state lands, which serve as an object lesson to private landowners. In the farming region east of the Appalachians in Virginia, Maryland, and Delaware most of the land is too valuable for agricultural purposes to be devoted to timber growing. As in other farming regions, however, every farm should have its woodlot, and in many localities where no extensive timbered areas remain the planting of windbreaks and shelterbelts is advisable. A recent study of conditions in Delaware indicates that the growing of timber crops, without considering the value of forest belts from a protective stand-

point, is an excellent investment on lands worth not more than $15 per acre. Portions of farms which have been worn out through continued cultivation may be planted to advantage. The species recommended for planting in Delaware are chestnut, red and pin oak, tulip poplar, and black locust. The last-named tree will do well on sandy soils not only in Delaware, but throughout Maryland and Virginia. There is one drawback, however, to a locust plantation, and that is its well-known enemy, the locust borer, which is greatly to be feared in many localities. Where it is prevalent it is useless to plant locust. Another rapid-growing tree which is likely to prove of considerable commercial value when planted on fertile, fairly heavy, well-drained soils in the more northern portion of the State is the hardy catalpa. Excellent trees for windbreak and roadside planting are the European larch and black locust.

Except for the early planting in New England, the farmers of Ohio and Indiana have been the first to recognize the value and importance of forest planting. There are a number of rapid-growing broadleaf species adapted to this section which give early returns and which have been exploited by commercial nurserymen. In these two States and generally throughout the central valley district the practice has been to plant rapid-growing kinds. For example, in West Virginia and southwestern Pennsylvania, walnut, locust, sugar maple, red oak, chestnut, and catalpa have been planted for posts, mine props, and timber; in Ohio, black locust and catalpa for posts; in Indiana, black locust, catalpa, and walnut; in Kentucky, black locust, catalpa, tulip poplar, maple, and walnut, principally for mining timbers and posts; in Tennessee, locust, maple, and cedar; in Missouri, catalpa, locust, walnut, osage orange, cottonwood; in Arkansas, locust and walnut.

While black locust and hardy catalpa give excellent returns when planted under proper conditions, the most far-reaching and valuable result of the planting of these species has been to call attention to forestry and stimulate general interest in the growing of timber crops. Our present knowledge of conditions shows that without doubt the planting of other and more slow-growing species is fully justified from an economic standpoint. The state authorities of Indiana and Ohio are taking a leading part in promoting farm planting. Along the Ohio River in southern Indiana and Ohio there is much land now being farmed which would actually produce a higher return per acre if planted with black locust, or even with some of the slower-growing but more valuable hardwoods. Nowhere in the United States can there be found a more striking example of the need of timber belts for securing the highest results from agriculture even where there is scarcely an acre of waste land on any farm. Throughout this district every farmer should make provision for the future by renewing his

woodlot, by planting where necessary, and should see to it that sufficient shelterbelts are planted to insure future protection to his homestead, his growing crops, and his orchards.

SOUTHERN FOREST.

Of the total area of cut-over forest land which is not restocking naturally, about 70 per cent will reproduce pine if it is protected from fire. About 30 per cent, therefore, or more than 5,000,000 acres, will require artificial restocking. While most of this lies within the southern pine forest, there are limited opportunities for planting in the Appalachian Mountain region and in the northern portions of Georgia, Alabama, and Mississippi. Planting thus far has been almost altogether with rapid-growing hardwoods, such as catalpa, and for the most part has been ill advised, and serves as no indication whatever of the lines along which planting should progress, since hardy catalpa is unsuited to this region. For quick returns of small-sized material, black locust is especially suited to the mountain and Piedmont sections of Georgia, and white oak is good for posts and ties, though for posts it will be best to grow loblolly pine and treat it with preservatives. Carolina poplar grows rapidly in the South and makes good chemical pulp; but since it has been found that pine can be used for pulp, the value of planting poplar is somewhat doubtful.

In general, however, planting is unnecessary throughout this region, because reproduction is abundant wherever there is protection from fire.

CENTRAL TREELESS REGION.

The central treeless region includes the States of Illinois, Iowa, North Dakota, South Dakota, Nebraska, and Kansas, the prairie district of Minnesota, and the portions of Oklahoma and Texas lying west of the hardwood belt.

Forest planting has been a part of the progress in agriculture and therefore has been most extensive in the region of best agricultural development. Nebraska and Kansas lead in the acreage of plantations. About 840,000 acres have been planted within this central region, but there should be more than 14,000,000 acres.

As in the past, planting in this region will be almost entirely a private enterprise, carried on in connection with farming. While protection is, and in general will be, the primary object, planting should be done from the commercial standpoint, since by using only profitable species it will easily be possible to secure the double advantages of shelter and ornament, and at the same time to derive a revenue from all the plantations. (See Pl. XXII, fig. 2; Pl. XXIII, fig. 1; Pl. XXIV.)

Until quite recently forest planting had declined or was at a standstill in the older farming regions of Illinois, Iowa, Nebraska, and Kansas, and the cutting of mature plantations offset the new planting that was being done. Shelterbelts are increasing in the newer farming districts of the Dakotas and Oklahoma, and, owing to their evident value to plantations, interest in planting is now being revived. This growth in interest is shown by figures from forty-five of the principal commercial nurseries which handle forest-tree seedlings. In 1906 they sent out 24,530,929 young trees; in 1907, 38,540,202; and in 1908, 40,791,193. Seventy per cent of these trees were hardwoods and 30 per cent conifers.

The advantage and the necessity of having a certain proportion of the land in agricultural districts under forest cover have been clearly demonstrated; 5 per cent of the prairie region should be forested, and farther west on the plains 3 per cent may very well be devoted to tree growing.

The Forest Service of the Department of Agriculture is prepared to render practical assistance to farmers and tree planters, and since the opportunities have been foremost in the treeless States, the first efforts of the Forest Service were directed toward this region. There has been a wide distribution of literature in these States, and for several years Kansas and Nebraska have received more of the Forest Service literature than any other States.

In Illinois planting is no longer being practiced so extensively as in the past. The total area planted by the farmers of this State is somewhat more than 15,000 acres, but the areas which might very properly be devoted to tree growing aggregate some 1,500,000 acres. The species chiefly used have been black walnut and hardy catalpa.

Probably 125,000 acres have been devoted to timber growing on the farms of Iowa. This is but a small fraction of the 2,000,000 acres which should be planted in order to keep the proper balance between cultivated land and woodland, and here again forest planting seems to be on the wane. Species which have been planted chiefly are, in the order of their predominance, silver maple, black walnut, cottonwood, boxelder, willow, ash, elm, and catalpa.

In the western and southern prairie portions of Minnesota it is estimated that there are nearly 1,200,000 acres which should be planted. There have already been planted about 115,000 acres, and there is now a slight increase in the extent of planting. The species which are most commonly planted are boxelder, cottonwood, maple, willow, ash, and elm.

In North Dakota more than 1,500,000 acres could very properly be planted with forest trees, in addition to the 52,000 acres which it is estimated have thus far been devoted to this purpose. It is interesting to note that in general throughout the entire State, which is a

relatively new farming region, tree planting is rapidly on the increase, chiefly for shelter and for post production. The species mainly used are boxelder, cottonwood, green ash, and willow.

About 122,000 acres have thus far been planted in South Dakota, and at least 1,600,000 acres should be planted by farmers. As in North Dakota, the interest in tree planting is growing, and, in addition to the species which have been most popular in North Dakota, elm and soft maple have been used extensively in South Dakota.

Nebraska has an area of planted timber estimated to be 192,000 acres, and there are something more than 2,000,000 acres more which might be planted to advantage to utilize waste lands and provide adequate protection for crops in the farming districts. While Nebraska has deserved and won the name of "Tree Planting State," the indications are that planting is slightly declining, particularly in the eastern portion of the State. As in the other Western States, the chief purposes of past planting have been to secure shelter and to produce fuel and posts. Cottonwood, boxelder, ash, elm, and maple have been the species largely planted. Reliable data show that 175,000 acres have been planted with forest trees in Kansas, and at least 1,700,000 acres should be planted. In addition to the hardy species which have been most largely used in Nebraska, black locust, hardy catalpa, and black walnut have been favorites with the Kansas farmers.

In the prairie region of western Oklahoma over 21,000 acres have thus far been planted with trees. It remains for the landowners in this relatively new farming region to plant nearly 300,000 acres for the best interests of their section. The species chiefly used are black locust, hardy catalpa, maple, and cottonwood.

The planting of black locust, cottonwood, and catalpa is also being done on a rapidly increasing scale on the prairies and plains of the western half of Texas. Hardly more than 13,000 acres have, however, as yet been planted, and it will probably be many years before the ranchmen in this region will accomplish the planting of the 2,500,000 acres which should be devoted to tree growing.

As a whole, particularly for shelterbelts and windbreaks, the central region needs to use more conifers.

WESTERN REGION.

The western region includes the Rocky Mountain and the Pacific Coast States. Much of the forest land in the Western States is within National Forests, and forest planting on these lands is chiefly a federal problem. But there are abundant opportunities for private planting in the valleys of southern California and on irrigated lands throughout the region. It is essential that more than 2,500,000 acres of land in this region in private ownership should be artificially

forested, and by far the greater portion of this planting must be done by farmers or ranchmen.

On irrigated lands the primary purpose of planting by private owners is identical with that in the central treeless region. Most of the irrigation projects are subject to strong winds, and protection is essential. Forest planting by farmers in California is needed for the protection of watersheds, as shelterbelts for orchards, and for the production of commercial timber.

The area of planted timber in this region is 38,862 acres, of which 37,100 acres have been planted by private landowners. A very interesting and economically valuable object lesson in planting is the aggregate of 20,000 acres of eucalypts in California. This presents a remarkable example of profitable returns from a quick-growing species, and shows the value of further experiments with exotic species in the United States.

If proper species are used there should be no great difficulty in securing good shelterbelts and woodlots on western irrigated lands. Eastern trees have proved most useful in the limited planting done thus far. Ash, cottonwood, locust, elm, and introduced species, such as Norway spruce and Scotch pine, have been planted. The choice of species depends chiefly upon temperature, since moisture can be controlled by irrigation. (Pl. XXIII, fig. 2.)

The development of planting in California has been more rapid than in any other State in the region. High returns from plantations have already been secured, and the southern part of the State is likely to be a great producer of eucalyptus (hardwood) timber for many uses, especially furniture and wagon stock. It is estimated that there are at least 1,000,000 acres of land in the valleys of southern California upon which continued irrigation for the production of fruit is not feasible, but which can be irrigated from time to time, and are well suited for the growing of eucalypts. (Pl. XXV.)

The principal forest lands outside of National Forests lie in Washington and Oregon, west of the Cascades, and in California. Possibly 25 to 30 per cent of the cut-over lands in the former section will be devoted eventually to agriculture. Adequate fire protection and proper forest management will provide for a future timber supply on the remainder of these lands. Planting will be a small factor only, and supplemental to forest management, in order to restock areas that can not reseed naturally, because of lack of seed trees.

CONCLUSION.

From the problems of the various planting regions of the United States it appears that just as the greater portion of the forest area of the country lies in the East, so the amount of land requiring artificial restocking is greater in that region. Conservative lumbering

and forest planting within National Forests and by private owners in the West will maintain a permanent supply of valuable western conifers, but in the East the perpetuation of the best species of hardwood is dependent largely upon the activity of the private landowners. It is absolutely essential that the people of each State, and particularly farm owners, should realize the immense importance of individual effort in providing for a future timber supply. The quantity of land that can be restored to value through forest planting by the Federal Government or by the States is in the aggregate small and comparatively insignificant as compared to the great area that must be forested eventually by private landowners, among whom the farmer stands first and foremost.

In case the prospective planter finds himself confronted with a local problem concerning which he feels the need of special advice, he should correspond with The Forester, Forest Service, Washington, D. C., provided, of course, that the authorities of his own State are not in a position to furnish him with the information he desires.

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PLATE XXII.

FIG. 1.—INTERIOR OF A 50-YEAR-OLD WHITE PINE PLANTATION NEAR BRIDGEWATER, MASS.

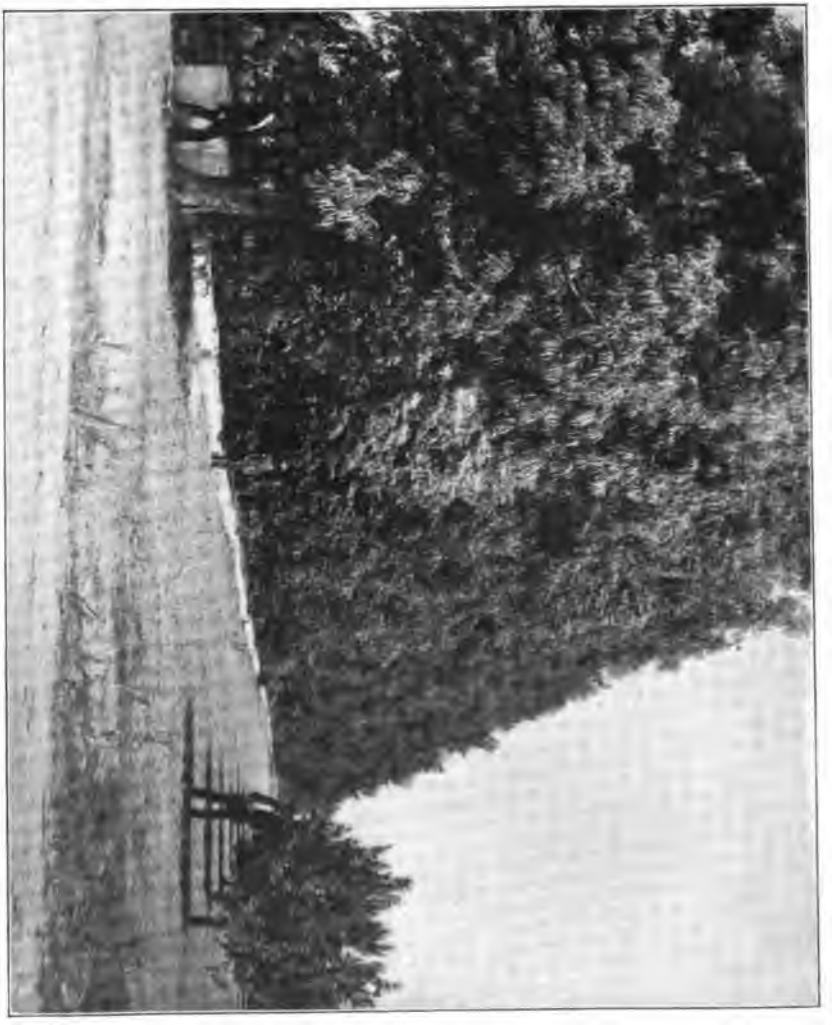
FIG. 2.—A 27-YEAR-OLD EUROPEAN LARCH PLANTATION, DUNDEE COUNTY, ILL.

Yearbook U. S. Dept. of Agriculture, 1909.

FIG. 1.—A 20-YEAR-OLD BLACK WALNUT PLANTATION FROM SEED, TIPPECANOE COUNTY, IND.

FIG. 2.—A 3-YEAR-OLD PLANTATION OF BLACK LOCUST ON IRRIGATED LAND NEAR TWIN FALLS, IDAHO.

PLANTATION OF HARDY CATALPA, RENO COUNTY, KANS.



EUCALYPTUS WINDBREAK TO PROTECT A LEMON ORCHARD, SAN BERNARDINO COUNTY, CAL.

W. L. Howard.

PRACTICABILITY OF FOREST PLANTING IN THE UNITED STATES.

BY

WILLIAM L. HALL,

Chief of Division of Forest Extension, Bureau of Forestry.

[REPRINT FROM YEARBOOK OF DEPARTMENT OF AGRICULTURE FOR 1902.]

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PRACTICABILITY OF FOREST PLANTING IN THE UNITED STATES.

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INTRODUCTION.

While it can not be said as yet that forest planting is practicable for the United States as a whole, it does apply to a large part of the country, and is of constantly increasing importance. The purposes for which forest planting is practicable differ so widely for different parts of the country that the subject will be considered here with reference to the several regions of the United States, in each of which the objects of planting are closely related.

The considerations which determine the practicability of planting as a part of forestry for any specific region are the following:

(1) The present supply of useful timber.

(2) The need of the forest to provide shelter, protect the soil, or conserve moisture.

(3) The capacity of the forest to produce another crop, either unaided by man or aided in ways less expensive than planting.

(4) The value of the ground for other purposes than forest growth.

(5) The protection which can be given from fire or other grave dangers.

(6) Indications as to a fair return on the investment.

Other considerations in the past carried great weight, though they are now largely removed. One of these was the lack of information as to the habits and requirements of forest trees, in consequence of which forest planting was merely an experiment. Sufficient information is now available to make success almost a certainty in the planting of a large number of our most valuable trees. If the individual has not the needed information he may easily get it from his more experienced neighbor or from the foresters of the State or the National Government. So, too, the question of market has become less problematic than in the past. The timber owner now has a market for many kinds of timber for which there was no sale twenty-five years ago.

As the uncertain factors in planting have been cleared away, the area for which planting is practicable has steadily enlarged. It will now pay to plant in localities where ten years ago it would have been

necessary only to encourage natural reproduction. To-day the possibility of natural reproduction on such land has gone, and only by planting may the stand be renewed. Within the next ten years, unless there is a marked improvement in the methods of handling forest lands, the reproductive power of the forest will be impaired to such an extent by fire, stock, and other injurious agents that planting will become a necessity over still greater areas.

Regions in which Forest Planting is not Practicable.

Forest planting is not practicable in those regions which are as yet well timbered, and in which the reproductive power is sufficient to renew the stand as the trees now standing are cut away. Broadly speaking, this includes in the South the hardwood region of the Southern Appalachians and the pine belt from Virginia to Texas. In the Northeast it includes the spruce forests in New York, Vermont, New Hampshire, and Maine; it includes also sections elsewhere, as in the Allegheny Mountains. In the West it includes the heavily timbered portions of California, Oregon, and Washington, and smaller sections elsewhere.

Regions in which Forest Planting is Practicable.

In other parts of the United States than those named above there are some sections in which the supply of timber is wanting or is becoming insufficient to meet the demand, and in which natural reproduction is not sufficient to insure a second crop. Fortunately, it is possible to discuss the question according to the geographic divisions—the Eastern States, the Middle West, and the Western States. For these regions it must be considered whether it will pay better to use for other purposes the land and the capital invested in planting, and import the lumber needed from other regions; whether the land can be protected from fire and other dangers; and whether satisfactory returns may be reckoned upon.

PLANTING IN THE EASTERN STATES.

In the Eastern States planting at present may be considered under the following heads: Farm wood lots, impoverished farm lands, and cut-over nonagricultural lands.

FARM WOOD LOTS.

It is the experience of both the practical farmer and the forester that it pays on every farm to maintain a wood lot for the production of timber for farm uses. The wood lot furnishes fuel, posts, poles, logs, and lumber; it shelters from wind the buildings, orchards, gardens, and fields, and in summer it furnishes shade. It is universally recognized as an essential component of the well-balanced orderly farm.

The wood lot pays well, even if it has to be located on valuable

agricultural land; but as on nearly all farms there is variation in fertility, it pays better to use the best land for farm crops and locate the wood lot on the less valuable portion, if that can be done without interfering with any of its important uses.

In the Eastern States the wood lot usually consists of a remaining portion of the original forest. Year after year the trees have been cut for fuel and other purposes until in the average wood lot the stand is now far from perfect. Not realizing the injury resulting from pasturage, the farm stock (horses, cattle, and sheep) have been permitted to range at will among the trees, with the result that no young trees have come up to occupy the ground as the mature ones were removed. The prevention of reproduction has been the most potent cause of decline in many wood lots. So important a factor in farm thrift is deserving of better treatment. Stock should be rigidly excluded and every means taken to encourage natural reproduction. But in places where natural reproduction takes place slowly, planting will be necessary. It is a good plan to permit natural reproduction to do its best, and where it fails, to plant. Where the surface of a wood lot has become compacted by long and continued tramping, and covered by a dense sod, it will be very difficult to renew the forest even by planting. Many times it will be better to start another wood lot by planting in a different place, and then, after a few years, to clear up the old one and turn it into other uses. The main thing is never on any farm to abandon the principle of the wood lot. If natural reproduction fails, plant; if one site becomes inhospitable to tree growth, try another and keep trying until the wood lot is successfully established; for on the best farms there should not fail to be from 5 to 20 per cent of the land in timber.

IMPOVERISHED FARM LANDS AND CUT-OVER NONAGRICULTURAL LANDS.

In the Eastern States are extensive areas of both of these classes of land. It is true that in some regions natural reproduction is coming about satisfactorily. For example, abandoned farm lands in the North are here and there being covered by White Pine and Spruce; in Virginia, Maryland, Delaware, and New Jersey with Scrub Pine and hardwoods; and in the South Atlantic States with Loblolly Pine. Where the process is going on rapidly enough, no thought need be given to planting. But there are wide areas in all of these States where natural reproduction is lacking, and where the land, long since cut over by the lumberman or abandoned by the farmer, is unproductive and a burden to the owner. (Pl. II.) The questions are: Can these lands be planted with assurance of a profitable return? Can the capital locked up in them be made productive? While a few of the States are owners of this class of land,[a] it is mainly a problem for the

[a] Pennsylvania, New York, and Connecticut.

private owner. On land of this character the first four considerations mentioned at the beginning are removed. The region has not now a large surplus of timber, and the land in question is without a natural reproductive tendency and without value for other purposes. The practicability of planting, therefore, depends upon the possibility of protecting the land and the return to be expected. The question of protection must be answered with respect to the individual case. Injurious insects and trespassing live stock frequently have to be dealt with, and are sometimes sources of grave danger. Fire is even a more serious menace. In some places protection from fire is easy, in others it is very difficult. Abandoned farm lands of the character described are not usually much grown up to brush, and by the cutting and plowing of fire lines they may without much cost be made quite secure from damage by fire. Where cut-over lands occur in large tracts it is usually possible to devise systems of control whereby they may be protected from fire, but where they consist of small scattered tracts in localities where fires are frequent and not controlled, it is almost useless to attempt to keep fire out, and, therefore, to plant.

For the land which can be protected there remain to be considered the cost of planting, the rate of growth, and the probable returns.

ESTIMATES OF COST AND RETURNS PER ACRE FOR PLANTED WHITE PINE.

The estimate following is intended to cover the cost and returns for 1 acre of planted White Pine in New England. The estimate is general and applies fairly to a very large section, where an area of 100 or more acres is to be planted.

The seedlings are to be grown by the planter near the tract which it is proposed to plant, and are to be once transplanted while in the seed bed. At the end of forty years from the making of the seed bed the entire product of the plantation is to be sold on the stump for box boards. The land is classed as worth $6 per acre, and the assessed value per acre is reckoned as increasing at the rate of 75 cents per year up to the time of cutting. Taxes, which are estimated at $1.80 per $100, are reckoned by decades for the sake of convenience. It will require 1,210 trees to plant the acre at a distance of 6 by 6 feet. The first cost of 1,210 seedlings in seed bed, including cost of construction of the latter and supervision, is estimated at $2. After the land is cleared, at the end of forty years, the value doubtless will be as great as at the beginning, but the value of the land is not taken into consideration. Should $6 be added to the $140 which it is estimated could be secured for the timber product, it would simply increase by that amount the profits of the transaction. Likewise, if the value of the land at the beginning were less than $6, the profits would be greater by the difference plus accumulated interest. The statement following shows the items and amount of the investment for 1 acre.

Expenses on 1 acre for forty years.

First year:	
Cost of seed and starting seedlings in nursery	$2.00
Value of land	6.00
Third year:	
Transplanting to nursery, at $1 per 1,000	1.21
Fourth year:	
Transplanting to field at $4.50 per 1,000	5.45
Taxes for first decade on average assessed value of $9.38, interest to be reckoned for thirty-five years	1.69
Taxes for second decade on average assessed value of $16.88, interest to be reckoned for twenty-five years	3.04
Taxes for third decade on average assessed value of $24.38, interest to be reckoned for fifteen years	4.39
Taxes for fourth decade on average assessed value of $31.88, interest to be reckoned for five years	5.74
Total	29.52
Amount at 3 per cent compound interest	70.70

At the age of forty years the average planted White Pine in New England is 8 inches in diameter and 48½ feet high.[a]

It is estimated that the land will produce at least 40 cords of wood suitable for use as box boards, which should sell on the stump at not less than $4 per cord, bringing $160 per acre. Deducting from this sum the amount at 3 per cent compound interest, $70.70, there remains $89.30 as the return on the investment. This is equivalent to a return of about $2.25 per year from the time of planting to the time of cutting, a very satisfactory return considering the fact that it is secured from land which is useless for any other purpose, and which without a timber crop would be a source of constant expense for taxes. The timber crop not only gives a return on the money invested, but it makes productive the capital locked up in the land.

For the sake of definiteness in the estimate, it is assumed that the stand will be cut off clean at the end of forty years. In actual experience, probably the wiser course would be to leave at least half the stand for ten or twenty years longer. During this period the trees would not only grow rapidly, but the quality of the lumber would greatly improve, and in consequence it would command a correspondingly higher price.

In this estimate the cost is the record of actual experience; the rate of taxation, that at present common in New England; the rate of growth, the average of planted White Pine in New England; and the price less than that which has already been received where fair access was had to market. The estimate is corroborated by actual experience.[b]

Since the estimate is based upon present conditions, it more nearly

[a] Determined from a series of 60,000 measurements in White Pine plantations.

[b] J. D. Lyman, in The Forester, August, 1901.

applies to a plantation established forty years ago, and to be marketed now, than to one established now and to be marketed forty years in the future. In the last forty years White Pine lumber, as represented by the Detroit market, has advanced fully 100 per cent. If it should advance in the same proportion in the next forty years, the return on this investment would be proportionately greater.

While this estimate is for White Pine it is applicable to Red Pine and Norway Spruce over a large part of New England. From Massachusetts to North Carolina the Chestnut may be counted on to give commensurate returns when grown for telegraph poles and railroad ties, and likewise the Black Locust for posts.[a] In Virginia, the Carolinas, and Georgia is much land that could be planted to Loblolly Pine with indications of profit equal to the estimate. Actual examples of planting the Loblolly Pine are lacking, but its rapid growth strongly indicates great usefulness as a planted tree. Black Walnut may also be counted as a profitable tree for planting in the Southeastern States. It is adapted only to the more fertile soils, and requires from seventy-five to one hundred years to produce lumber of great value.

It happens in many cases that there are protective as well as financial considerations. Soil which erodes easily by water or is so sandy as to be blown by the wind may be retained and improved by a forest cover. A forest furnishes the best possible cover for the watersheds of storage reservoirs. For this reason fully as much as for the financial one, several water companies are planting extensively in the Eastern States. Among the most important of these are the Metropolitan Water and Sewerage Board of Massachusetts, which is planting on the watershed of its immense reservoir at Clinton, Mass., and the water department of the city of Woonsocket, R. I. (Pl. III, fig. 1). In both cases the planting is being done in cooperation with the Bureau of Forestry. The water companies supplying the cities of New Haven and Hartford, Conn., are also planting large tracts about their reservoirs under plans prepared by the director of the Yale Forest School, and the city of Middletown, Conn., is similarly planting under directions from the State forester.

The States of New York, Pennsylvania, and Connecticut have recently acquired extensive areas of nonagricultural land, and are now engaged in the work of foresting them. The State of New York especially is undertaking work of great magnitude. Within the Adirondack Preserve are about 60,000 acres of burnt-over waste land which it is planned to reforest. A beginning was made last year by the planting of 750 acres, and it is proposed hereafter to plant at the rate of 1,000 acres per year until the waste land is covered. Nurseries for the growing of seedlings are now being established.

[a] Albert Neilson, in Forestry and Irrigation, August, 1902.

FOREST PLANTING FOR THE PROTECTION OF WATERSHED AT CLINTON, MASS.

[Courtesy of T. F. Borst, forester, Metropolitan Water and Sewerage Board, Commonwealth of Massachusetts.]

FIG. 1.—FOREST NURSERY OF THE METROPOLITAN WATER AND SEWERAGE BOARD, COMMONWEALTH OF MASSACHUSETTS.

[Courtesy of T. F. Borst, forester.]

FIG. 2.—WASTE LAND SUITABLE FOR FOREST PLANTING, MINNESOTA.

Considering the work which is being done by States, municipalities, corporations, and individuals, the present operations in forest planting in the East far exceed any similar activities in the past. Moreover, the planting now being done is based upon sound business principles, and is bound to show satisfactory returns, the effect of which will be widely extended planting throughout the Eastern States.

PLANTING IN THE MIDDLE WEST.

The Middle West can best be considered under three headings: The White Pine belt; the main agricultural region; the semiarid region.

THE WHITE PINE BELT.

Land on which White Pine has been the predominant tree occupies large portions of the States of Michigan, Wisconsin, and Minnesota. This discussion refers to those cut-over and burnt-over areas of White Pine land which, on account of their stony, sandy, or otherwise infertile condition, can not be converted into productive farms. (Pl. III, fig. 2.) That it is well suited to the production of timber, its original condition proved, and the only hope of ever making it profitable is to put it again into forest. That the present supply of White Pine is already very short is indisputable. Over large areas where it grew best it is already exhausted, and in the remaining districts it is greatly diminished. Except where recently lumbered or yet uncut, reproduction has failed. Protection from fire is as important here as on the cut-over lands in the Eastern States, and may be accomplished in the same way. For large tracts adequate systems of protection may be devised without proportionately great expense, but small tracts surrounded by land loosely administered can not easily be protected.

The restocking of White Pine lands seems to be a State rather than an individual or National problem. Conditions favor its management in large tracts for the production of standard dimension lumber. This will require a rotation of from sixty to eighty years—a period too extended for individual enterprise. The National Government could well afford to undertake the work, provided it owned the land. But land of the character in question has mainly become alienated. The States own very large and increasing holdings, on account of school grants and tax forfeiture. Probably the next decade will be marked by a systematic attempt at the reforestation of their waste land by all three of these States.

Gen. C. C. Andrews, State chief fire warden of Minnesota, speaks thus of the condition in his State:[a]

> It is estimated that there are in scattered localities, and principally in northern Minnesota, 3,000,000 acres of waste, sandy, hilly, or rocky pine forest. Hence, if

[a] Seventh Annual Report of the Chief Fire Warden of Minnesota.

the State were now to begin to plant that land with pine at the rate of 37,500 acres per year the whole would in eighty years become a well-stocked normal forest, yielding perpetually thereafter 675,000,000 feet B. M. annually. * * * Besides yielding a splendid revenue from waste lands, which otherwise would every year become more barren and useless, it would afford steady labor for thousands of people, and among indirect benefits it would tend to beautify our landscape, modify the temperature, fertilize the soil, and replenish the water supply. * * * There are remaining in Minnesota from 20 to 30 billion feet of pine, and this is now being cut at the rate of 1½ billion feet per year, and the greater part shipped out of the State. Anyone can judge for himself how long this main supply will last. The average value of standing pine in Minnesota is now $4 per 1,000 feet B. M. This value has risen $1 per 1,000 feet within the past four years. * * * From these facts it is clear that it would be wise economy for the State of Minnesota to at once begin to acquire possession of the various tracts of waste land and plant them with pine.

A preliminary survey of 1,000 acres in northern Minnesota has already been made, the planting of which will follow as soon as arrangements can be made for it. According to the plan now proposed, this is to be only preliminary to much more extensive work. A State forestry commission already exists. The next legislature will consider a bill to appropriate money for this commission and authorize it to acquire for the State land suitable for forest purposes. If this is done, active reforestation can be begun.

The State of Michigan last year set aside a tract of 60,000 acres of cut-over pine land for an attempt at systematic forestry. It is, first, a problem of protection from fire, and after that of restocking. The present growth, even where best, is scarcely more than enough to furnish seed. Mr. Thomas H. Sherrard, who represented the Bureau of Forestry in a cooperative investigation of the tract last year, has this to say in regard to the practicability of planting:[a]

Wherever protection is certain planting would become perfectly feasible. Where planting is necessary these lands could be planted with pine at an average cost per acre of not more than $8. This sum would cover the cost of raising seedlings in seed beds, transplanting to the nursery, and the final transplanting of the 3-year-old seedlings at a distance of 6 by 6 feet. Thinning and tending are considered unnecessary. The investment, at 3 per cent compound interest, would amount to $35 per acre at the end of 50 years. The value of the product at the end of this period, roughly estimated at 40 cords per acre, would be $120, assuming a stumpage price of $3 per cord. This represents a net gain of $95, or $1.98 an acre per annum. This estimate is for White Pine. The figures given are purposely conservative.

THE MAIN AGRICULTURAL REGION.

This includes the States of the Missouri, Mississippi, and Ohio valleys, between the White Pine belt on the north and the heavily forested region on the south. From this great agricultural region the most valuable timber has now largely been removed. What remains is contained principally in wood lots belonging to individual farms. The region also includes a very large area once reckoned as treeless,

[a] Forestry and Irrigation, October, 1902.

yet prodigious energy among the settlers has provided for many such sections fully as much timber as is now to be seen in some sections once heavily timbered. The Kansas State board of agriculture reports 142,984 acres of planted forest in 1900. Nebraska claims over 200,000 acres. The valley of the Arkansas River in Kansas, forty years ago entirely treeless, appears now to the casual observer to be as fully timbered as the valley of the Wabash, which was once entirely forested.

The only system of forestry practicable throughout this region is the system of wood lots on individual farms. The land is too valuable for agricultural crops to be devoted to timber culture on a large scale, but no farm is so valuable but that it would be worth more with a well-kept wood lot, covering from 5 to 20 per cent of its area. In addition to wood lots, a most sensible practice prevails of establishing protective shelter-belts and rows of trees for wind breaks in places of the greatest exposure. Such plantations add immeasurably to the comfort of the farm in addition to the timber supplies which they furnish. It is often possible in the Middle West, as in the East, to put the wood lot on the less valuable part of the farm, which is always desirable when conditions will permit it.

In addition to wood lots and protective belts, it is practicable in places in the Middle West to establish forest plantations for the production of fence posts, telegraph poles, and railroad ties, purely as a financial investment. Large plantations of Hardy Catalpa, Black Locust, Red Cedar, and Osage Orange have been established on the very best agricultural land, and compete favorably with wheat and corn as money-producing crops.[a]

THE SEMIARID REGION.

Lying between the agricultural region and the mountains, the semiarid region embraces several sections of large extent, which through the production of timber would attain a value otherwise impossible. The most notable of these sections is that containing the sand hills in west central Nebraska. They cover an area of 100 by 150 miles, which throughout is well adapted to the growth of pine timber. A large amount of land in the sand hills is yet retained by the Government. In April, 1902, the Niobrara and Dismal River forest reserves, containing altogether 208,902 acres, were established in this section for the purpose of making a systematic trial at forestation. The Department of the Interior has invited the Department of Agriculture to undertake this work, which is now fairly begun. The first planting will be done in 1903. (Pl. IV.) If inexpensive but successful planting methods are found, a large tract of planted timber should result

[a] Bul. No. 37, Bureau of Forestry, U. S. Dept. Agr., "The Hardy Catalpa," describes several large commercial plantations of Hardy Catalpa.

from the work of the next decade in that region. There are also other districts in the semiarid region which have the same general conditions and in which the Government still owns most of the land. It would be a wise policy for it to establish reserves for forest planting in all these sand-hill districts. The land is valuable for forest trees, and the fact that settlers have passed over and around it for thirty years without taking it up, shows that it is valuable for nothing else.

Planting in these sections is an undertaking which logically falls to the General Government rather than to the State or the individual. The investment extends over too long a period for individual activity, and besides the Government owns most of the land. The same reasons exist, therefore, for the Government to undertake this work as for the States to undertake planting in the White Pine belt.

PLANTING IN THE WESTERN STATES.

In the Western States, where the agricultural land is limited in area, but highly developed through irrigation, forest planting will necessarily be confined almost exclusively to the mountains. It is true that in certain parts of southern California the profitable culture of the Eucalypts for timber is being carried on even on very valuable agricultural land. The climatic adaptations of this tree prevent its general use, and no other tree grows rapidly enough in that region to pay on valuable land.

The necessity of a forest cover on the Western mountains is not now doubted by anyone who has studied the conditions at all deeply. Successful irrigation depends upon a regular flow of water, which in the Western States is dependent in an unusually high degree upon the condition of the forest upon the mountains. A forest of good density acts in two ways—both beneficial. It greatly lessens evaporation and it diminishes the surface run-off, causing the water, instead of rushing off the ground in surface torrents immediately following a rain, to percolate gradually through the soil and to appear at lower levels in the form of springs.

It is often the case in the Western mountains that where the forest is needed most it is totally lacking or else is too thin to exert any appreciable influence on stream flow. This is true of very large portions of the San Gabriel and San Bernardino Mountains, in southern California, where by fire and grazing the forest has been entirely destroyed. (Pl. V, fig. 2.) Some of the best orange-producing and lemon-producing land in the United States depends upon water from these mountains for irrigation. With water it is worth from $1,500 to $2,000 per acre, while beside it is land of exactly the same character worth nothing, because there is no water available to irrigate it.

The restoration of the forest on these denuded mountains would, according to experience in similar countries, so increase the water

FIG. 1.—GENERAL VIEW OF FOREST TREE SEED BEDS, DISMAL RIVER FOREST RESERVE, NEBRASKA.

FIG. 2.—INTERIOR VIEW OF FOREST TREE SEED BEDS, DISMAL RIVER FOREST RESERVE, NEBRASKA.

FIG. 1.—PART OF THE DISMAL RIVER FOREST RESERVE, NEBRASKA ON WHICH FOREST PLANTING WILL BE UNDERTAKEN.

FIG. 2.—FOREST PLANTING ON MOUNTAIN SIDES DENUDED BY FIRE, SOUTHERN CALIFORNIA.

supply that much more of this land could be irrigated. Increase the supply enough to irrigate 1,000 acres of this land, and the value of $1,000,000 is created. There are many places where this result can be brought about within twenty years by planting at an expense of less than $50,000. Under such conditions the practicability of planting is unquestionable. In a less degree this condition exists widely in the Western States.

A careful system of forest management, which involves planting on denuded watersheds, is of fundamental importance to the effectiveness of large irrigation works.

This is a work far beyond the capacity of the individual, or even the State, and belongs inherently to the National Government. Not only does the Government own the land, but in numerous cases where conditions to warrant planting exist they occur upon the National forest reserves, which are located in most cases to include the watersheds of important streams. On the reserves, of course, only the Federal Government has the right to plant. Since the Government will in the future develop irrigation systems, it will be compelled, for the protection and efficiency of its own property, to maintain such a system of forestry. Unless the barren watersheds are planted, great damage must result to the reservoirs from filling with silt, for the wash from bare mountain slopes such as are to be found in southern California is enormous.

The Government has already begun experimental planting in the San Gabriel, San Bernardino, and San Jacinto forest reserves in southern California, which are estimated by the United States Geological Survey to contain 1,447,000 acres of brush land, upon which all valuable timber has been destroyed by fire. Since the reserves were established, several years ago, the danger from fire has been so reduced by a vigorous patrol system that a large proportion of the brush land is now safe enough to warrant planting. Two or three years' experimental work has developed economical and rather rapid methods of planting, and during the past season the planting has been extended over several hundred acres by a field party of the Bureau of Forestry. Knobcone Pine has been planted on the driest spots; Incense Cedar, Sugar Pine, and Western Yellow Pine on the moister and cooler places.

In the case of the mountain slopes upon which planting is being done, the importance of a forest cover in conserving the water supply for the cities of Los Angeles and Pasadena and contiguous country is considered so great that the Los Angeles County Forest and Water Association and the Pasadena board of trade have contributed liberally toward the work. The planting gives promise of excellent results.

What the Government is doing on these reserves it might well do on a number of others in California and other Western States. There

is great need of planting on the reserves in Arizona, New Mexico, and Colorado, where natural reproduction is insufficient, and careful studies should be made as soon as possible to ascertain the best trees to plant and the right methods to follow. After that is done nurseries may be established to grow trees for the planting.

Walter Mulford

THE PRACTICE OF FORESTRY BY PRIVATE OWNERS.

BY

HENRY S. GRAVES,
Superintendent of Working Plans of the Division of Forestry.

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THE PRACTICE OF FORESTRY BY PRIVATE OWNERS.

By HENRY S. GRAVES,

Superintendent of Working Plans of the Division of Forestry.

INTRODUCTION.

The general movement in the United States in favor of conservative forestry began about twenty-five to thirty years ago. During this time, through the medium of newspapers and magazines, Government and State publications, and scientific and other associations, the importance of a strong federal and State forest policy has been emphasized, and private owners have been urged to adopt careful methods of handling their woodlands. Some of the results of this agitation are well known, such as the withdrawal from sale of about 47,000,000 acres of public land to be held as federal forest reservations, the establishment of State reservations in New York and Pennsylvania, the institution of a system of fire patrol in Maine, New York, New Hampshire, Minnesota, Wisconsin, and Pennsylvania, the appointment of forest commissioners or similar officers in Maine, New Hampshire, New York, Pennsylvania, Minnesota, Wisconsin, and Kansas, the organization of two forest schools in the East and two in the West, as well as the establishment of courses of lectures on forestry in many agricultural colleges, and the creation of a lively interest in the subject throughout the country. What effect the efforts of the advocates of forestry have had on the handling of private woodlands is, however, not known to the general public, many believing that, with the exception of a few conspicuous examples, real forestry has not been practiced at all. As a matter of fact, a large amount of work has been done along the lines of conservative forest management, although it has not been known under the name of forestry. It is nevertheless a fact that wherever land is managed with the intention that it shall yield repeated crops of timber, and is so treated that the producing power is maintained at a high point, there true forestry is practiced.

A large number of owners in nearly every State have carried on work which comes entirely within this definition of true forestry, but their holdings are for the most part comparatively small. The majority of the large owners, the lumber companies, have not cut their forests with reference to the future production of timber, except in some of the spruce sections of the Northeast. Throughout the far West, and in many parts of the East, the danger from fire is so

great that most owners have not dared to leave money invested in the forest in the form of small growing trees which otherwise might be utilized with present profit. In other sections, notably the Lake States, the taxes are so high that many owners could not afford to hold the land for future crops of timber, even if there were no danger from fire. In such localities it has been the object of lumbermen to remove the timber as soon as possible, with no intention of ever cutting over the land a second time. This system of lumbering, together with the great destruction of the forests by fire, has given the impression that there is no careful forestry in this country at all, and the work of the many small owners and of the few large owners who have managed their lands conservatively has been overlooked. It is the purpose of this paper to review briefly the work already done by private owners along the lines of forestry, much of which, though lacking system and imperfect in methods and results, shows the intention of true forestry and marks a great advance in the treatment of our forests.

In order to come in touch with private owners who have carried on such forest work as has been described, the Division of Forestry issued a circular letter of inquiry regarding the prevailing methods of handling woodlands. Answers were received from about 2,000 persons from forty-six States and Territories, nearly 1,000 of whom stated that they had done some work which might be classed as forestry. The material was so voluminous that only a general account of the work can be given here, with special reference to the more instructive examples.

EARLY EFFORTS OF PRIVATE OWNERS.

The earliest attempt at conservative forestry of which the writer has record was made in Connecticut in 1730, when Jared Eliot, of Guilford, in connection with Governor Bulkley and a Mr. Livingston, of New York, started a small blast furnace at Old Salisbury. The wood used in making the charcoal needed in the furnace was cut from the neighboring woodlands, and instead of clearing the forests, as was usually done, a careful system of thinning was adopted. Only the large trees were cut, while the small specimens were left standing to shade the ground and to grow to a larger size. Tradition states that under this system the owners returned for successive crops every twenty years, and it is reported that timber is still being cut periodically from this same land. A similar system of careful cutting is said to have been used by a large number of farmers in New England early in this century, and the practice was without doubt inaugurated very soon after the country became thickly settled. Some farmers went further than simply to select with care the trees which they wished to use or sell, and made thinnings with the sole view to improve the remaining trees. Thus, it appears that in 1840 B. F. Cutter introduced on his land in Pelham, N. H., a system of improvement cuttings. It seems that an abandoned field had sprung up to white pine

and gray birch, and that when the trees were about 20 years old the birches began to be broken by the wind and to die. Wishing to save the wood before it decayed, Mr. Cutter cut out all the birch, leaving the pines untouched for twelve years longer. He then saw that a considerable number of the latter were being crowded out and were dying from lack of growing space and light, and accordingly he thinned out all the weak and unlikely trees, leaving the strong, vigorous specimens for the final crop. His labor was repaid by the wood which he took out and the improvement of the remaining trees, which grew more rapidly on account of the increased amount of light and space.

The planting of forest trees on waste lands was begun in Massachusetts at a very early date. It is said that between 1740 and 1750 an experiment in planting trees for ship timber was made at Pembroke, Mass. Tradition relates that the plantation was a complete success, and that timber was cut from it about 1810. Another early plantation was made in Bristol County, Mass., in 1790, where a farmer stocked a field with young oaks by sowing it with acorns. One of the first experiments in planting of which there is record was made in 1819 at Chelmsford, Mass., where Rev. J. L. Russell transplanted a large number of pitch-pine seedlings from a field, which he wished to cultivate, to a stretch of barren drift sand. He was much laughed at by his neighbors, but to their astonishment the trees flourished, and in twenty years he had a fine grove of pines, 6 to 8 inches in diameter. Of still greater interest and value as an illustration is the plantation of Zachariah Allen, at Smithfield, R. I., who planted about 40 acres of waste land in 1820 with chestnut, oak, hickory, and locust. The seed was sown in plowed furrows on the smooth ground, and in rough places was dropped in holes made by a hoe or a similar implement. A careful account of all expenditures and receipts was kept, and at the end of fifty-seven years the books showed a profit of 6.92 per cent on the capital invested. Similar plantations were doubtless made in the early part of the century, but no definite record of them can be obtained.

Planting on a large scale was begun in eastern Massachusetts in the present century as early as the forties. The best known of the plantations are those of Richard Fay, at Lynn, who planted about 200 acres, in 1846–1850, with oak, ash, maple, Norway spruce, Scotch pine, and larch, and of Joseph S. Fay, at Woods Hole, who a few years later stocked about 125 acres with trees. On Cape Cod it has been the custom of the farmers for many years to sow the seed of pitch pine on waste lands. The method is to sow the seed with a machine or by hand in plowed furrows about 4 feet apart. The cost is estimated to average $3 to $5 per acre. While pitch pine is the tree most commonly planted, oak, ash, and other species have also been used. The plantations in eastern Massachusetts are being investigated by the

Massachusetts Forestry Association, and records have already been obtained of 10,000 acres of land artificially stocked with trees. (Pl. XXV, figs. 1 and 2.)

CAREFUL THINNING.

In many sections of the country planting by owners of small holdings is very important and should be encouraged in every way possible, but the proper care of the existing woodlands is of much greater importance. Many observing farmers have already studied this problem and manage their wood lots with great intelligence. (Pl. XXVI, fig. 1.) The extracts which follow were selected from a large number of letters written by farmers in nearly every section of the country and are given to illustrate the character of the work done.

A farmer in Rochester, Mass., writes as follows:

Ten years ago I began to cut all trees except white pine. I trim the trees as high as a man can reach easily, namely, 6 to 8 feet, leaving all limbs on the ground. I leave the outside trees, which are exposed to the sun, as a protection to the trimmed trees. I thinned and pruned the trees when about 20 years old, leaving about 200 per acre.

The following statement was received from a farmer at Wrentham, Mass.:

About thirty years ago I began to cut out the dead and unthrifty timber; also cut inferior kinds to give more room to the better ones. Cut early in winter, before deep snow interferes with the work of picking up and hauling. Never cut at the edges of a wood lot, but leave thick growth to act as a wind-break. Do not cut the same land each year, but only so often as dead wood or inferior growth makes it worth going over with ax and team.

An owner in Granville, N. Y., writes that his grandfather began in 1850 the method of work shown in the following extract:

I go over each lot and select such trees as I consider to be ripe, including all of any size with broken or dead tops. These trees I blaze or mark with an ax. I then send men to cut these trees and instruct them to use care in felling not to injure any young trees if they can avoid doing so. The tops I have worked up so as to leave the ground clear for the next growth.

This careful work is by no means confined to the Northeast, but letters were received from men in nearly every State to the effect that a very large number of farmers endeavor to use conservative methods in cutting their wood lots. Thus, one farmer writes from Tennessee:

1. We use all the timber that blows down.
2. We cut any that seems to be diseased or dying.
3. We take the crooked, knotty, scrubby trees.
4. If we need more wood when the above kinds are used, we cut the oldest trees that seem to do the least growing.

A Virginia correspondent states:

For fuel I cut the old, dead, gnarled, crooked, and unshapely trees, leaving the straight, vigorous, and more valuable. When cutting for fence material, I take only one or two here and there, thinning out to give others more room. Tops, logs, brush, etc., are burned in winter and ashes spread among growing trees.

FIG. 1.—WHITE-PINE GROVE IN WHICH THINNING AND PRUNING HAS TAKEN PLACE. PLYMOUTH, MASS.

FIG. 2.—PLANTATION OF WHITE PINE, EIGHTEEN YEARS OLD. SOUTH ORLEANS, BARNSTABLE COUNTY, MASS.

FIG. 1.—A PITCH-PINE PLANTATION, ESTABLISHED BY SOWING. EAST BREWSTER, MASS.

FIG. 2.—LAND CUT PERIODICALLY FOR SPROUTS, WITH YOUNG GROWTH IN THE FOREGROUND. BARNSTABLE COUNTY, MASS.

A Michigan man writes that he marks all the trees he wishes to leave standing and cuts the remainder, piling and burning the brush.

A California farmer writes as follows:

In the winter season, when time will admit from farm work, I cut out all the poorest growth, leaving only thrifty trees, about 200 to the acre. I draw all brush to some clear ground and burn it. I burn all chips and trash and obtain a large amount of ashes, which I throw around my apple trees.

CAREFUL CUTTING OF SPROUT LAND.

It is well known that most hard woods send up sprouts from the stump, especially if the trees are cut before the sap begins to run in the spring. (Pl. XXVI, fig. 2.) Many farmers take advantage of this fact, and cut their woodlands clear, and then wait fifteen to thirty years for a second crop of sprouts. It is common to hear this practice vigorously condemned, but as a matter of fact, it is one of the established systems of forestry used in Europe as well as in this country. For the production of firewood it has many advantages; and if the cutting is done carefully, the growth will frequently amount to not less than 1 cord per acre per annum. Thus, New England farmers calculate that about twenty-five years are required for cleared sprout land to produce 25 cords of wood per acre. This system has been in practice since the early settlement of the country, and in many places old oak stumps may be seen from which repeated crops of sprouts have been cut and which have become, under the treatment, gnarled, misshapen, and covered with irregular knobs. As a rule, no precautions are used to assist in the prolongation of the life of the stumps, but the correspondence of the Division of Forestry shows that a considerable number of men have taken this point into consideration in cutting their sprout lands. Thus, a New Jersey farmer writes that he cuts his stumps slanting from the center like the roof of a house, taking care not to injure the bark. In this way no rain water is allowed to collect on the stump and thus hasten its decay. A number of correspondents stated that they are accustomed to cut the stumps close to the ground, so that independent roots will be formed and the wind will not break off the sprouts, as would often be the case with high stumps. Letters were received from many farmers stating that they always cut the trees in winter, as the stumps are apt to lose their sprouting power if cut during the growing season.

CONSERVATIVE LUMBERING.

The most extensive work in forestry by lumbermen has been done in the spruce forests of New York and the New England States. The pioneer of this movement was E. S. Coe, of Bangor, Me., who saw very early that if only the large trees were cut and the small ones left standing, the land could be cut over at repeated intervals. In letting contracts, therefore, he restricted the cutting to 10, 12, or

even sometimes to 14 inches on the stump. As a result he cut over certain tracts a second time and obtained as large a cut as at first, using the same diameter limit. A large number of owners have followed his example and limited the cutting of spruce to a certain size, but so far as the writer is informed the cuttings have not been regulated in a systematic way, except on the tracts belonging to Dr. W. S. Webb and Hon. W. C. Whitney, in the Adirondacks, where the land has been lumbered under a system devised by the Division of Forestry. The usual method of the lumberman is to issue instructions to the choppers not to cut trees under a certain diameter on the stump, and later on the stumps in the woods or the butt logs on the landings are measured in order to see that the regulation has been complied with. On the two tracts just mentioned, however, not only is there a diameter limit for the cutting, but all trees are marked which are to be cut, and seed trees above the specified size are left when necessary. The lumbering is strictly regulated according to the following rules, and competent inspectors are employed to see that they are rigidly carried out:

(1) No trees shall be cut which are not marked.

(2) All trees marked shall be cut.

(3) No trees shall be left lodged in the woods and none shall be overlooked by the skidders or haulers.

(4) All merchantable logs which are as large as 6 inches in diameter at the small end must be utilized.

(5) No stumps shall be cut more than 6 inches higher than the stump is wide.

(6) No spruce shall be used for bridges, corduroy, skids, slides, or for any purpose except building camps, dams, or booms, unless it is absolutely necessary on account of lack of other timber.

(7) All merchantable spruce used for skidways must be cut into logs and hauled out.

(8) Contractors must not do any unnecessary damage to young growth in lumbering; and if any is done, they must discharge the men who did it.

The International Paper Company has within a few years adopted a system of restricting the cutting of spruce on a part of its lands in Maine, New Hampshire, Vermont, and New York. The method is to cut no spruce under 12 inches in diameter on the stump. Fir, however, is cut clean in order to reproduce the ground to spruce. On one tract of 120,000 acres, in New Hampshire, an inspector has been employed to watch the lumbermen to see that they do not cut any small spruce for lumbering purposes, except for camps, bridges, dams, cribs, piers, and corduroy. On a considerable amount of land, however, this company cuts the spruce clear without regard to the future production of timber.

An interesting method of forest work is that used in the southern

part of New Hampshire, near Lake Winnepesaukee, where the lumbermen, in a number of cases, have left white pine trees for seeding purposes. The trees are usually spreading, scrubby specimens, which are of no great value, but which, nevertheless, would bring a small price for box boards. The lumbermen calculate that about two to five good seed trees of pine per acre, evenly distributed, usually secure an excellent natural reproduction. It is the custom, therefore, to leave standing not less than two or three spreading trees per acre.

Some of the lumbermen in Maine, in cutting second growth white pine, leave standing all trees under 12 inches in diameter, and calculate that they can return for a second crop in about twenty years.

In the Allegheny Mountains much of the lumbering does but little damage to the forest. This is usually not due to a conscious intention on the part of the lumbermen to protect the forest, but is because only a limited class of timber can be sold. Thus, one man in West Virginia writes that he cuts only the white oak, poplar, and walnut, leaving all trees under 23 inches in diameter. He states that he takes great care not to injure the young growth; that he is now cutting over a tract of 1,200 acres for the third time in twenty-six years, and that he expects to remove his fourth crop in five years more.

A novel plan of forest work has been initiated by the owner of about 4,000 acres at Kendalia, W. Va., who wishes to combine forestry with stock grazing. He is thinning the entire tract, removing the dying, overripe, or otherwise unlikely trees, and leaving all thrifty, sound specimens of all species. He then clears the underbrush and sows the ground to blue grass. The thinning is to be completed within a year or two, and the work of clearing and sowing to grass will be done gradually. It is the owner's intention to utilize the farm permanently for stock and to hold the growing timber as an investment for the future. The owner is making the experiment with the full understanding that the future value of his forest lies in the growth attained by the small trees now standing, and that when these trees are cut there will be no provision for natural reproduction. The work was begun in 1898, and 10 acres were treated in the way described in order to ascertain the expense and to test the behavior of the grass. It appears to be an entire success.

As illustrating the kind of forestry practiced by certain lumbermen in the South, the following letter is of interest:

I have just commenced to cut off 700 acres near Ohatchee, Calhoun County, Ala. I go over the land, cutting all the trees down to a diameter of 12 inches at the stump, or 2 feet above the ground. I leave all the oak and pine (longleaf yellow pine) and cut down all other growths clean, and leave the woods clean with the exception of the timber I leave to grow larger. These small trees are then thick enough, or as thick as they should be, to grow fast. I cut from this land about twenty large trees to the acre. This in log scale makes about 9,000 to 10,000 feet to the acre. I burn this land off every year, some time when the sap is not up, or any time between November and February. There are never enough leaves to make

enough fire to hurt the timber by burning it once a year. I am very careful in cutting this large timber to fall it so as not to inflict wounds on the trees to stay on the ground, as this will leave defects in the timber when it is cut, say twenty years from now. I do not leave small trees unless they have straight bodies, so when they grow up they will be useful timber. Inside of five years I will begin to leave sprouts that appear, so as to form another growth after this timber, now being left, is ready to cut. I use this land after it is cleaned up for sheep and hog pasture.

The instances of conservative lumbering described in the preceding pages are but examples of work which has been carried on by a large number of lumbermen. The systems have been devised by the owners themselves, and, while in many cases improvements could be made, the work shows that much more has been done in the way of forestry than is generally supposed.

FOREST MANAGEMENT UNDER SYSTEMATIC WORKING PLANS.

It has been said that forestry consists in managing woodlands with the expectation of obtaining repeated crops of timber. Systematic forest management requires, first, the determination of the amount of timber that can be obtained at different periods, and, second, the management of the forest in accordance with a definite plan which shall secure the greatest returns in the long run.

In most instances the conservative forest management hitherto practiced in this country has been without system, and the owners have not known whether or not the methods used were successful in maintaining the productive power of the land. The first large forest put under systematic management with a definite working plan was that belonging to G. W. Vanderbilt, at Biltmore, N. C. The work was organized in 1891 by Gifford Pinchot, now the Forester of the Department of Agriculture, on about 4,000 acres. Additional tracts have since been purchased to the extent of about 100,000 acres, and the whole area has been brought under systematic treatment. An expert forester is employed to superintend the work, and there is a corps of trained rangers. A certain amount of mature poplar has been lumbered, and the system of cutting employed has been very successful in bringing about an excellent reproduction of that tree. Improvement cuttings of various species, chiefly for cord wood, are made in the portions of the tract nearest the market, and a certain amount of planting is done every year. The tract is admirably protected from fire, theft, and stock grazing, and a complete system of roads and trails is being laid out.

A great deal of the work which is being done at Biltmore would not be practical on many other large tracts (managed solely for profit) in other sections or even in the same section of the country. The kind of systematic forest management practical for lumbermen will be more along the lines practiced on the Webb and Whitney tracts, in the Adirondacks, already mentioned in the discussion of conservative lumbering.

During the past year a considerable amount of systematic forest work has been organized on private tracts under advice from the Division of Forestry. This has been the result of an offer made in October, 1898, by the Secretary of Agriculture for the Division to give advice and assistance to private owners in handling their woodlands. Within a year after the offer was made applications were received from owners in thirty-five States for assistance, the total area covered by these applications being about 1,600,000 acres. The preparation of working plans for these tracts and the supervision of their execution is now one of the important branches of the work of the Division of Forestry.

FOREST FIRES.

The first condition necessary for successful forestry is an adequate protection from fire. In sparsely settled countries, where there are large unbroken stretches of forest, this is the first problem to be solved, and until the danger is reduced to a minimum owners will not lumber with reference to the future.

In farming countries, where the holdings are small and interspersed with fields and roads, the fires can be successfully prevented by careful watching. Hitherto the majority of owners of both large and small tracts have relied chiefly on careful watching and, in case of a fire, on extinguishing it before much damage is done. Further precautions are, however, now coming into use, such as clearing wood roads, burning fire lines, piling and burning tops after cutting, etc. Some of these measures are practical only on small woodlands, but those who have tried them write enthusiastically of their success.

A farmer in Pennsylvania describes his method of protection as follows:

> I make fire lines 2 perches wide. Just before fall of leaf I cut brush to prevent return of sap. In spring I sprinkle with water to limit the extremes of fire and burn the space inside. Each year the growth is less and grass begins to grow. The cost of cutting brush is $3 to $4 per acre.

An owner of a farm on one of the small islands off the coast of Maine writes:

> We cut two strips across narrow places and cleared all brush, so that the grass would grow and, if necessary, in case of fire, the land could be plowed. The work was started five years ago and the wood nearly paid expenses. This method was adopted because of the danger of fire on the outer ends of the island, where fishermen frequently camp, and we feel that in case of fire on a point we could fight it and keep it from the best part of the island.

A Michigan farmer makes a practice of cutting roads through the forest, harrowing and seeding them to grass, and then allowing stock to graze on them. The system was initiated in 1885, and in the judgment of the owner the expenditure of about $100 per annum has been a profitable investment.

The construction of fire lines around and through the wood lot is

practiced by farmers in many sections of the country. The custom is especially common among Western farmers on the plains, who have made artificial plantations. In the South the same system is used, but farmers more often burn over the whole of their land every year.

The most disastrous fires occur on large tracts, where the construction of fire lines would in many cases be impracticable. The methods used by lumbermen and other large owners to protect their property are, therefore, of special interest. The most common method, where any attempt at fire protection is made, is an organized fire patrol. Thus, some companies operating logging roads have men follow every train during the dry season to extinguish any fires that may be set by the locomotives. Other companies have extra rangers during the dry times who patrol the woods, watch campers, and in case of fires repair to them at once.

This system is well illustrated by the following letter from a lumberman in Forest County, Pa.:

> In dry times we patrol especially exposed parts. In spring and autumn, during dry weather, our woodsmen all have orders, no matter what they are doing, whenever they see smoke arise, to go to it and put out the fire. It is usually done by back-firing entirely around and watching it until we are sure the fire is out. By this means we have kept serious fires from our timber when we are working. It costs us a few hundred to a thousand dollars annually. Usually successful, but not always. The outlay is profitable.

The most perfect system of fire protection in this country known to the writer is that used by Dr. W. S. Webb on his tract of 40,000 acres (Nehasane Park) in the Adirondacks. The park is divided into four sections, each watched over by an experienced woodsman, who lives at a point from which all parts of his section can be easily and quickly reached. The houses of the rangers are connected by telephone, and there is an admirable system of roads and trails. In case of fire in the park, the superintendent and the rangers are notified by telephone, and all available men are called out to extinguish it. In case of a severe fire along the railroad which traverses the park, Dr. Webb is notified by telegraph, and a locomotive is dispatched to draw the "fire service" to the scene. This consists of a large tank placed on a flat car, to which is attached a box freight car containing a small engine used to pump the water from the tank, and a complete outfit of hose, axes, and other tools used in fighting fires.

A lumberman owning 2,000 acres in Huntingdon County, Pa., describes his method of fire protection as follows:

> I divide into lots say 200 acres, cut roads through, and rake all rubbish and burn it before the season gets too dry. This makes good fire-breaks. When very dry I put a watchman on for every 200 acres. The first year's cost was $400; that of succeeding years $60.

The owner pronounces the above method entirely successful, and is confident that the outlay has been profitable.

FIG. 1.—A PLANTATION OF PITCH PINE, ABOUT FIFTY YEARS OLD. SOUTH ORLEANS, BARNSTABLE COUNTY, MASS.

FIG. 2.—A GROVE OF WHITE OAK ESTABLISHED BY DROPPING THE ACORNS IN HOLES MADE WITH A CANE. EAST GREENWICH, R. I.

A Pennsylvania lumber company writes:

In dry times we have men watch exposed places; also have 100-barrel tank on a car, with 600 feet of 2½-inch hose. Two streams can be thrown from this tank, as there is a powerful pump attached with two connections for hose. In 1898 we expended $900 fighting fire before we rigged up the tank. This year, with more fires, the expense has not exceeded $100, and we have been able to control every fire. Not over 10 acres have been burned over this season as against 200 last year.

A Michigan man writes that he burns the tops of the felled trees in wet weather after he has finished logging, and states that the measure has been successful in protecting his timber land. He also says that after an experience of twelve years he considers the outlay a good investment.

One owner of 30,000 acres in Clark County, Wis., has for six years made a practice of clearing up and burning the tops after lumbering, and considers it a practical and profitable undertaking.

In the pine belt of the Atlantic coast it has long been the custom for many owners to let a light fire run through the forest annually, or once in several years. The fire is set in winter or early spring, when the ground is damp and it can be kept under control. The measure is very successful in protecting the standing timber, but in many cases it destroys the young seedlings, and the ultimate effect on the forest is injurious. The method of burning used in the turpentine forests is shown by the following letter from Louisiana:

We rake the dry straw (needles), grass, and chips from the base of the trees, about 3 feet all around, and the woods are burnt within the time prescribed by the Mississippi law, to lessen the growth of grass. The work was begun about eight to ten years ago, and cost about $120 for 1,600 acres. The custom of raking the ground at the base of the trees is considered as part of the turpentine business. This method is adopted by nearly all turpentine producers. The raking is done with ordinary garden rakes, and has been the means of preventing many forest fires. The raking is commenced about one week before Christmas or earlier, if the straw is done falling, and continues all through January.

The cost of raking and burning is estimated by the crop. About 10,000 boxes constitute a crop, and the cost of raking and burning is about $12 per crop. I work about 10 crops every year, and pay on an average $120 to have them raked and burned properly; and the outlay, in my judgment, has proven both wise and profitable.

The custom of burning over the forest in winter or early spring is also common among lumbermen and farmers in California and other Western States.

FOREST PLANTING.

The great bulk of the forest planting has been done in the States west of the Mississippi River. In the Eastern States, except in a few instances, the planting has been on a very small scale and usually as an experiment. Reference has already been made to the extensive planting in eastern Massachusetts, where not less than 10,000 acres have been artificially restocked with forest trees. (Pl. XXVII, fig. 1.) Nowhere else in the country, so far as the writer is informed, has so much planting been done on so limited an area. Record has been

obtained of a large number of farmers who have planted from 1 to 10 acres, and there are a few instances of planting on a more ambitious scale. The plantations described in the following pages are but a few of many instances, but they show the kind of work which has been done.

An interesting plantation is that belonging to Isaac Adams, at Moultonboro, N. H., covering altogether about 50 acres, and composed of white pine and Norway pine set out about twenty-five years ago. The trees have grown admirably, and, so far as showing what planted pine will produce, the experiment is very valuable. The cost of planting in the first place was, however, much more than it would be to-day.

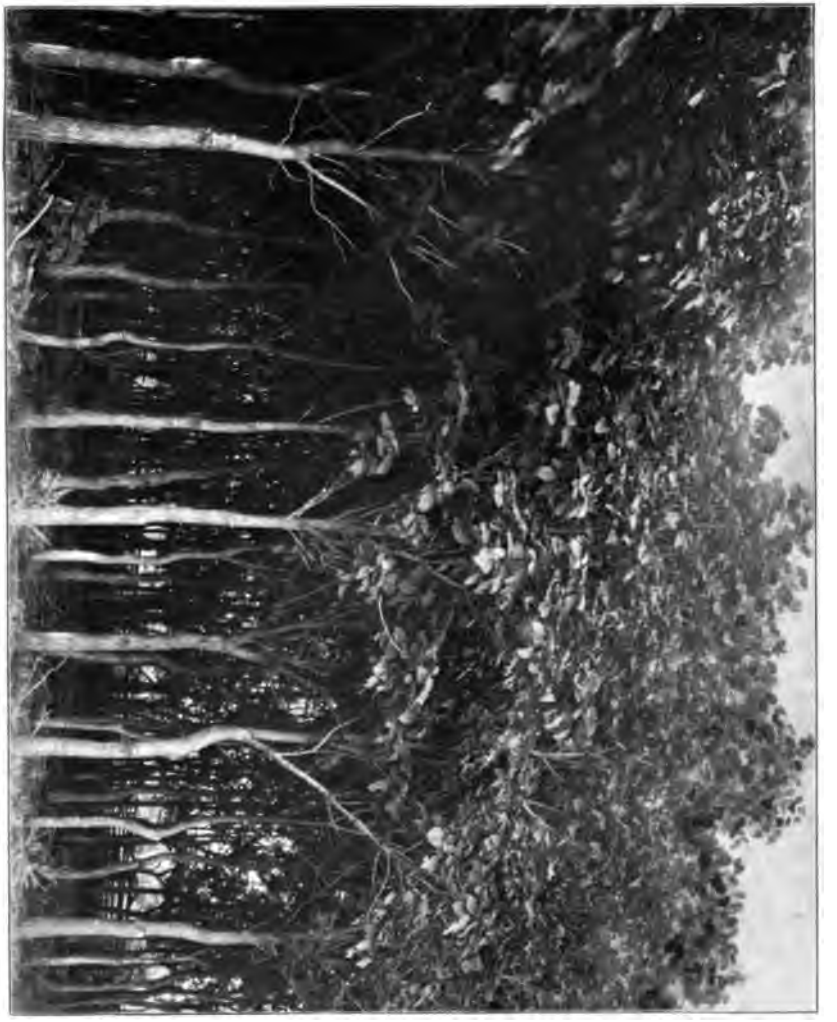
The experiments of J. D. Lyman, near Exeter, N. H., who planted several acres of waste land with pine, are of considerable value, because he was able to show that the cost of stocking land with trees can be reduced to about $3 to $5 per acre. His method was to sow the seed in hills 4 feet apart and to put from three to five seeds in each hill.

A very instructive plantation has been established by Mr. H. G. Russell, at East Greenwich, R. I., covering about 150 acres. (Pl. XXVII, fig. 2.) Like many American planters, he began with imported trees, namely, Scotch pine, Austrian pine, and Norway spruce, but later used native species. The work was begun in 1878, the intention being to form a wind-break, and in addition to provide an object lesson in forest planting.

The most extensive planting in Pennsylvania has been done by the Girard estate, near Pottsville. About 250 acres were set aside in 1881 to be treated under the methods of forestry. This tract was fenced and surrounded and crosscut by fire lines wherever there existed no roads adapted for that purpose. The trees used were white pine, Scotch pine, European larch, and white oak. The cost of planting varied from $18 per acre for the pines to $75 for the oaks. The planting of trees on the barren gravel at the edge of the reservoirs is of special value.

Another interesting experiment in planting in Pennsylvania has been undertaken by the Morrison and Cass Paper Company, at Tyrone. About 2,000 Carolina poplars were planted in 1898, at an expense of $534.50. About half the trees were 10 to 16 feet high and the remainder somewhat smaller. They were planted 12 feet apart in rocky, worthless land.

The planting of trees along the banks of streams to prevent erosion has been undertaken in a number of instances. Thus, in Arkansas a correspondent states that he has planted red birch, native willows, and soft maple for 2 miles along a stream to prevent the washing of the banks. The plants were seedlings about 2 years old and were taken from the woods. Similar work has been done at Mahwah, N. J., on the estate of Theodore Havemeyer.



A CATALPA PLANTATION.

In Ohio tree planting was begun very early. In 1830 Ezra Sherman, of Preston, planted about 15 acres of locusts, as well as an avenue along the public highway for about 200 rods. In 1870, 180 trees were cut down and 1,500 posts were obtained, netting $525. A certain amount of planting on a small scale is now done by farmers in Ohio, Indiana, and Illinois, but most of it is for the purpose of forming wind-breaks.

In most sections east of the Mississippi the natural reproduction of the forest is so abundant that planting has been little resorted to. Thus, where the loblolly pine flourishes the abandoned fields are often entirely seeded in a few years to young trees. So prolific is this regeneration that it has long been the custom in certain sections of the South to allow worn-out land to spring up to pine, and when the trees are 30 to 50 years old to clear and cultivate the land. Thus, there is a regular rotation of field and forest crops.

Natural reproduction is very prolific throughout the humid regions of the country, and old fields, if not pastured or continually burned over, eventually return to forest. Planting is very desirable for small owners, who, by the expenditure of a small amount of money or labor each year, can gradually stock the waste portions of their farms, but for lumbermen and other large owners planting on an extensive scale will, in the majority of cases, not be profitable.

On the Western plains, where timber is scarce and has a high market value, tree planting is very important, and it is here that the great bulk of the work has been done (Pl. XXVIII). Extensive tree planting on the plains was begun about twenty-five to thirty years ago. Several States, notably Iowa, Kansas, Wisconsin, Nebraska, Missouri, Minnesota, Illinois, Nevada, and the Dakotas, passed laws about that time encouraging, by bounty or exemption from taxation, the planting of forests. In 1873 the timber-culture act was passed by Congress providing that a title could be obtained to 160 acres, or a proportionate part thereof, by those who planted 40 acres or a proportionate area. While the State laws had but little immediate result and the timber-culture act was frequently a source of fraud, an impulse was given to tree planting, and the great amount of work which has been done must be traced largely to the effects of these legislative acts.

The correspondence of the Division of Forestry shows that a large number of farmers have planted trees for wood lots or wind-breaks in all the Western States. The greatest amount of work seems, however, to have been done in Kansas, Nebraska, and Iowa. The estimate given for the total planted area of Kansas in 1898 by the State board of agriculture was 159,859 acres. The total planted area in the other States has not been determined, but this question, as well as the results of the experience obtained in tree planting, is under investigation by the Department of Agriculture.

Tree planting on the Western plains was taken up not only by

small private owners, but also by a number of the railroads. In 1870 the Kansas Pacific Railroad experimented with tree planting on a small scale in Kansas, and in 1873 the Atchison, Topeka and Santa Fe Railroad established four stations, planting altogether about 70 acres. The Northern Pacific Railroad established an experimental station of 40 acres at Casselton, N. Dak., and the Burlington and Missouri and the St. Paul and Sioux City railroads in the early seventies planted considerable stretches with trees to act as wind-breaks and snow-breaks. A certain amount of experimental work was also done by the St. Paul and Pacific Railroad. The most important plantation made by railroads was that belonging to the Kansas City, Fort Scott and Gulf Railroad at Farlington, Kans. The following interesting letter with reference to the work has recently been received from the firm that furnished the trees:

We furnished the trees for the Kansas City, Fort Scott and Gulf Railroad (now the Kansas City, Fort Scott and Memphis Railroad) and for the president of the above road. This plantation [railroad] is at Farlington, Kans., and the Hunnewell plantation is 4 miles west of Farlington. At first the railroad bought the trees and the section men planted them. Possibly 50,000 trees were so planted up to 1878. We sold Mr. Nettleton, the general manager of the road, chestnuts, walnuts, and wild black cherry (a total of 12,500), white ash, and European larch. In 1878 we grew for them, under contract, 100,000 *Catalpa speciosa* and 25,000 black walnuts. In 1879 we took the contract of planting the balance of the section, they to furnish land for us to grow the seedlings on and to break the prairie sod and cross plow it when rotted; we to then plant and take care of the trees until they were from 4 to 6 feet high. They were planted 4 by 4 feet, 2,722 to the acre, we to get 1¼ cents per tree when turned over. A large part—at least three-fourths—of the trees planted was *Catalpa speciosa*. A large number of *Ailanthus glandulosa* were also planted. These two kinds of trees did well. The chestnut, larch, white ash, and wild black cherry were an almost utter failure. Over 3,000,000 plants were set out. In 1881, I believe, we sold the Iron Mountain Railroad 200,000 catalpas.

In California the planting of eucalyptus has proved very profitable to a large number of farmers. The tree was introduced in 1856, and as early as 1874 there were estimated to be about 1,000,000 specimens of eucalyptus in California. No recent estimate of the acreage of plantations has been made.

No mention has been made of the planting of sand dunes at Cape Cod, Mass.; at the Golden Gate, San Francisco, and Casmalia, Cal., nor of the planting at various experiment stations throughout the country. This is all work of great value, but it is not private forestry, and it has, therefore, not been considered in this paper.

Walter Mulford

PROGRESS OF FORESTRY IN 1907.

By

Q. R. CRAFT,
Forest Service,

AND DIRECTORY OF FOREST OFFICERS, ASSOCIATIONS, AND SCHOOLS.

[Reprint from Appendix, Yearbook of Department of Agriculture for 1907.]

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PROGRESS OF FORESTRY IN 1907.

By Q. R. CRAFT, *Forest Service.*

ADVANCE OF AMERICAN FORESTRY IN A DECADE.

In the last ten years forestry has advanced in this country from an almost unknown science to a useful, growing profession. In that time the number of technically trained foresters has increased from less than a dozen to over 400. Ten years ago there was not a single forest school in the country; now there are several professional forest schools which rank with those of Europe, and a score more with courses in elementary forestry whose usefulness is steadily growing. Forest lands under management have grown from one or two tracts to many, aggregating 7,503,000 acres, scattered through 39 States. The National Forests have increased from 39,000,000 acres, practically unused and unprotected, to 165,000,000 acres, used, guarded, and improved both in productiveness and accessibility. The number of States which have State forests has increased from 1 to 10; and of those which employ trained foresters from none to 11. The membership of forest associations has increased from 3,600 to 15,800. Ten years ago, except for a few of the foremost botanists, European foresters knew more about American forests than did the people of this country. In Europe they were then using preservatives to prolong the service of beech ties, and so adding from twenty to forty years to their life. Here, on the other hand, scarcely a treated tie had been laid, whereas there are now 60 treating plants, 27 of which treat ties exclusively, and an engineer who recently returned from Europe reports that both in size and mechanical perfection the treating equipment of this country is ahead of any to be found abroad.

And yet American forestry has only safely passed the experimental stage and got ready to do something. Action, immediate and vigorous, must be taken if the inevitable famine of wood supplies is to be lessened. We are now using as much wood in a single year as grows in three, with only twenty years' supply of virgin growth in sight. Only the application of forest knowledge with wisdom, method, and energy, in the next ten years, can prevent the starving of National industries for lack of wood.

TIMBER A PROFITABLE CROP.

The growing of timber as a farm crop has gained a permanent place in American agriculture. Each time a thrifty farmer sees a neighbor cutting a supply of fence posts and obtaining, out of the same stock, enough firewood to pay for the work, or selling on the stump a quantity of saw timber, the product of a farsighted investment of fifteen, twenty, or twenty-five years ago (Pl. LXIV), he realizes more keenly the importance of the wood crop. A farm without a good woodlot is incomplete.

Where the rainfall is heavy, the woodlot can be maintained on land not the best for other purposes, while, in a region where good land must be selected, it is the opinion of experienced men that the trees pay for the ground they occupy, in protection to the farmstead, the orchard, or adjoining fields. With the shelter of a windbreak, less feed is required to winter stock, danger to an orchard from late frosts is reduced, and the comfort of the home, as well as its beauty, is greatly increased. Indeed, some owners have estimated the value of good groves at $1,000 an acre, on the ground that the value of their property is increased to that extent by the trees. Where the forest has been given attention, the returns have yielded a net profit of $4,

$6, $8, and $10 per acre. The choice of species, methods of planting and care, suitability of the soil, and local market conditions may vary so widely that it is difficult to generalize for the country as a whole. However, in every State a share of the farm can be devoted to growing timber with a profit in some cases nearly or quite equal to that obtained from agricultural crops. In addition, protection, the convenience of having farm repair materials at hand, and increase of farm values are secured.

That forest planting is increasing is evident from the increased demand for planting material. One nurseryman last spring shipped 400,000 jack pine seedlings to Nebraska alone. One order, for 10,000, was for planting in the vicinity of the Brunner plantation, in Holt County, an example of successful forest planting which has been of great educational value. The Government nursery at Halsey has also been most helpful in determining the adaptability of conifers for planting on sandy soils in Nebraska and adjacent States.

Plans have been made for a Florida tract, which involve the most extensive replanting ever begun in the South. The lands, situated in Marion and Citrus counties, include 3,000 acres of sandy brush and grass-covered land, which it will be necessary to restock by artificial means. Longleaf pine seed will be sown in spots as a means of accomplishing this.

In New England, New York, and Pennsylvania great interest has been taken in planting white pine and other species, while eucalyptus planting has been given much attention in California. The interior of one of the largest buildings in Los Angeles was finished in eucalyptus imported from Australia at $250 a thousand board feet. This tree grows very rapidly, and is especially adapted to California. Two companies have been formed, which will plant in the aggregate several thousand acres with eucalyptus. It is with this tree that the Santa Fe Railway is planting 8,650 acres near San Diego, to test its suitability for the production of ties.

The woodlot offers an excellent opportunity for the practice of forestry. It is accessible enough to allow of moderate cuttings at frequent intervals, and it may be protected from trespass and grazing, and from fire, its chief enemy, without an elaborate scheme of defense; then, taxation is not a great burden, because the revenue from farm supplies more than meets this item every year and thus prevents the accumulation of interest.

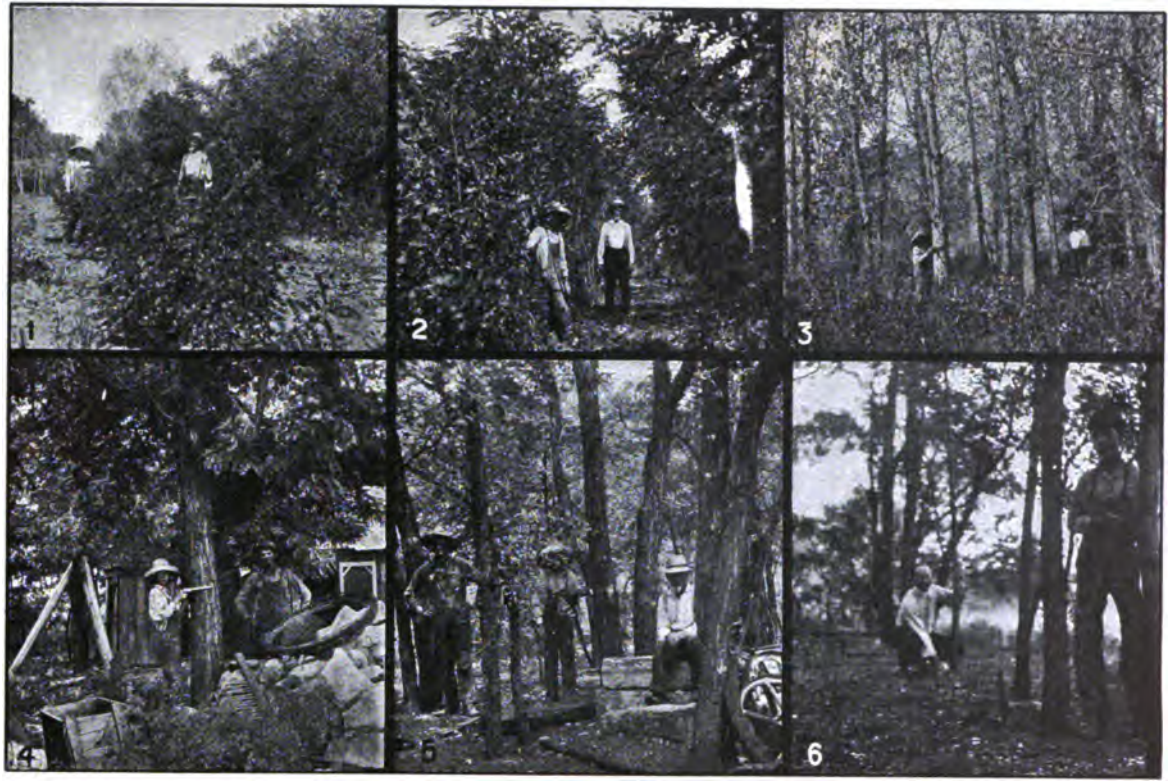
The application of intensive forestry to large tracts will naturally be of limited extent for some time to come. Closer utilization, provision for a second crop by the setting of a minimum diameter below which trees shall not be cut, and protection from fire are conservative measures which are steadily gaining ground. But looking into the future far enough to make provision for a third crop is not yet common, while efforts to bring forest lands to high productive capacity have as yet scarcely been attempted. In wealth of soil and high commercial value of native trees America has a decided advantage over Europe, where intensive forestry is paying well. American corporations and long-time investors, as well as the provident farmer, must go deeper into forestry to reap full reward.

An increased appreciation of the value of young forest is shown by the fact that in northeast Connecticut corporations are buying lands well stocked with trees 10 or 15 years old at prices which make it profitable to buy cut-over lands and restock them.

Experiments to learn what woods can be used to supplement the use of spruce for paper have shown conclusively that pulp of commercial value can be manufactured by the sulphite process from the hemlock of the Northeast and Lake States, Michigan tamarack, the loblolly and scrub pine of the South Atlantic and Gulf States, the cypress and tupelo gum of the southern swamps, the lodgepole pine and Engelmann spruce of the Rocky Mountain region, and the white fir and western hemlock of the Pacific coast. The experiments indicate that much of the pulp can be bleached and used for high-grade paper. White fir is especially suitable for the manufacture of papers where a long fiber and a good color of unbleached stock are desired.

California tanbark oak, hitherto considered of principal value for the tannin in its bark, has been found through timber tests to be suitable for cooperage and wagon manufacture. In strength it compares favorably with eastern oaks and hickory.

Recent tests on structural timbers—loblolly, longleaf, and Norway pines, and tamarack, for the eastern United States, and Douglas fir and western hemlock for the western—have shown longleaf pine to be the strongest and stiffest of the timbers mentioned, with Douglas fir a close second, while western hemlock, loblolly pine, tamarack, and Norway pine follow in the order given. Fortunately, Douglas fir and western hemlock, of which there are comparatively large supplies, have high structural merit, as has also loblolly pine, the principal tree in the operations of the southern lumber companies, which are beginning to look upon their forest holdings as part of their capital from which successive crops should be secured.



GROWING TIMBER AS A FARM CROP.

Trees for cutting every year. Combined shelterbelt and woodlot planted by John Tetlow, Downs, Kans., who for several years has secured from it his fuel and the posts necessary for the fences of a 320-acre farm: 1. Black locust, 3 years old from seed, for planting. 2. Trees 6 years old. 3. Future fuel supply; cottonwood 8 years old, 7 inches in diameter and 50 feet high. 4. Black locust 17 years old, diameter 11 inches, height 36 feet. 5. Black locust 33 years old, average height 33 feet, diameter, 5.7 inches; by good care at the first the trees are started to growing vigorously, and are cut for fence posts and fuel ahead of the [illegible] of fuel was secured from cottonwood planted in mixture. 6. Sprouts 3, 5, and 6 years old from trees [illegible]

Yearbook U. S. Dept. of Agriculture, 1907.

BETTER UTILIZATION OF YELLOW PINE.

At present not more than 50 per cent of the southern pine comes to the market in material of value. For many years effort has been made, with gradually increasing success, to utilize by distillation methods the defective logs and high stumps, which are rich in turpentine, and the slabs, edgings, and sawdust. The variety of methods employed, which are often faulty, and the lack of uniformity in the product, together with an objectionable odor, have caused wood turpentine to be considered an adulterated material, or, at least, a poor substitute for gum spirits. Through conferences and experiments, however, these difficulties are being overcome. Steam-distilled turpentine is found to be superior to that from the destructive distillation process. It is estimated that 30,000,000 gallons of turpentine, worth $14,000,000, can be produced from the waste wood of one year.

PRESERVATIVE TREATMENT OF RAILROAD TIMBERS.

The increase in the number and size of railroad treating plants during the year has been phenomenal. The scarcity of suitable timbers for railroad ties, combined with the high prices which they consequently command, is one of the reasons for the remarkable increase in the number of railroads which are beginning to treat and use the inferior timbers found along their own lines.

Increase in number of railroad treating plants.

1902	1903	1904	1905	1906	1907
7	10	13	15	15	27

Reports of the American Railway Engineering and Maintenance of Way Association show that the railroads which have been pioneers in treating timber have found it a paying investment. The Chicago and Northwestern Railway erected a tie plant in 1903, and since then has been treating hemlock and tamarack at the rate of about 600,000 ties a year, and now treats also beech, birch, and maple. The Santa Fe Railway has laid 13½ million treated ties, and the records show the average life of these first laid to have been 10.62 years. When, in 1904, a considerable amount of main-line track in New Mexico was washed out and replaced temporarily with untreated ties, treated ties were substituted as soon as they could be obtained, and the untreated ties were sent to the plant for treatment. According to the latest report, a total of 12,000,000 ties annually, or 12 per cent of the total cut, are now treated.

INCREASED EDUCATIONAL FACILITIES.

The progress of the year in forest education has been not so much in the establishment of new professional schools as in the strengthening of existing courses and the addition of new ones in established schools. The older schools, such as Yale, Biltmore, Michigan, and Harvard, have made steady growth. In fact, no previous year has witnessed such great success in outlining thorough theoretical and practical courses, and in securing the ablest men to conduct them.. This development in the educational field has given new departments of forestry to institutions which formerly had only courses on forest subjects, and added new men specially prepared to give instruction in particular subjects. As a result, the student's opportunities to secure technical forest training are better than ever before. Although a trip through the well-managed European forests and, even better, supplementary schooling abroad are of decided advantage, it is nevertheless true that for practical forest work under American conditions the forest student no longer need go abroad for his training. Like Yale, the schools of the universities of Michigan and Minnesota, as well as Colorado College, now have summer schools. During the year courses in forestry have been established at the University of Washington, the Washington State Agricultural College, Pennsylvania State College, and the Winona Agricultural Institute, Lake Winona, Ind., and a series of lectures has been begun at the Agricultural College of Utah. Practical work at the Michigan Agricultural College has been promoted by a grant of 40,000 acres of woodland by the State for forest demonstration, at Harvard by the gift, for a similar purpose, of a 2,000-acre tract of forest land at Petersham, Mass., and at the Pennsylvania State College by the conversion of several acres of the college domain into a demonstration farm woodlot. A six-weeks course in forestry has been added to the curriculum of the Connecticut Agricultural College at Storrs. The number of graduates from American forest schools, by years, is as follows:

1899	1900	1901	1902	1903	1904	1905	1906	1907
3	3	7	24	33	42	50	56	66

ADVANCE IN NATIONAL FOREST MANAGEMENT.

The National Forests, of which there are now (April 1, 1908) 164,963,555 acres, are constantly being used in more ways and by more people. Added experience is making possible the classification of the forests by types, with general instructions concerning the systems of cutting best calculated to secure in each type the production of the most wood of the best quality. In carrying out some of the timber sale contracts utilization is now almost as complete as in a German forest. The lumbermen who are cutting timber under regulation on the National Forests are competing in the market with those who cut outside—a direct argument that conservative forestry is thoroughly practicable from the lumberman's point of view.

The third year of systematic fire control recorded an improvement of 40 per cent over 1906 and 65 per cent over 1905.

Reduction of loss by fire on the National Forests.

	1905.	1906.	1907.
Area of National Forests.....acres..	97,711,455	127,167,271	162,023,190
Area of forest burned over.....do....	279,592	115,416	109,410
Amount of timber burned .....thousand board feet..	152,557	101,970	31,026
Value of timber burned.....	$101,282	$76,183	$31,590

Marked progress has also been made in securing prompt communication between the comparatively few men charged with the custody of wide areas. At present 1,185 men must guard 160,000,000 acres, an average of 135,000 acres, or 211 square miles, for each man. Ranger's cabins have been erected, and roads, trails, telephone lines, and bridges have been constructed.

The roads and telephone lines greatly assist in controlling fires, especially with the aid of lookout stations, which are established at strategic points. A typical example will illustrate how important are these improvements as means of overcoming distance in the administration of the forests. In the Southern Division of the Cabinet Forest there are two lookout stations, from which, with the aid of field glasses, nearly a million acres are visible. The system of patrol provides that once or twice each day, and constantly during the danger seasons, rangers shall scrutinize the forest from these lookouts. Notice of a fire can be sent by telephone, and the roads, trails, and bridges make it possible to obtain help promptly.

Construction of permanent improvements on the National Forests in 1907.

State or Territory.	Area of forests on which improvements were made in 1907.	Trails.	Roads.	Bridges.	Telephone line.	Fence.	Cabins.	Barns.
	Acres.	*Miles.*	*Miles.*	*Number.*	*Miles.*	*Miles.*	*Number.*	*Number.*
Arizona.....	11,470,870	91	1	1	107	24	29	8
California.....	23,082,994	485	.....	46	733	33.5	60	12
Colorado.....	15,748,772	166	14	16	470	104.5	63	6
Idaho.....	20,336,487	454	30	50	291	24	55	11
Montana.....	20,402,676	283	15	21	569	42.5	85	21
Nebraska.....	556,072	.....	.....	.....	95	1	2	1
Nevada.....	2,528,479	.....	1	.....	.....	2	4	2
New Mexico.....	8,303,979	182	8	14	67	64.5	42	4
Oklahoma.....	60,800	.....	.....	.....	15	1	.....	1
Oregon.....	16,463,535	613	44	25	373	107	27	8
South Dakota.....	1,263,720	.....	.....	.....	13	5	9	4
Utah.....	7,415,832	106	3.5	6	116	23	34	4
Washington.....	12,065,500	333	7	17	135	17	22	2
Wyoming.....	8,998,723	24	12	3	216	19	19	2
Total.....	141,698,379	2,737	135.5	199	3,200	368	451	86

The regulation of the range by the Government has proved a decided success. No longer hustled from one place to another in competition for insufficient feed, stock is now brought through to the end of the summer in better flesh and with fewer losses than formerly. During 1907 improvement of the range by protection was supplemented by experimental investigations to determine how the amount of forage can be increased; how plants of little value can be replaced by others more useful; how poisonous plants

can be got rid of or their effect upon stock counteracted by treatment; and to plan a system of handling stock that will result in the most economic utilization of the forage crop.

Experiments in seeding portions of the range with cultivated grasses were begun and careful detailed study was made of typical range areas to learn under what conditions the best native grasses propagate most successfully. An experimental pasture was constructed where the action of sheep under various systems of handling could be investigated and the effect of each system upon the forage crop ascertained.

FORESTRY IN THE STATES.

The year 1907 was characterized by larger opportunity than ever before for the practice of forestry under State organization. Delaware, Kentucky, Missouri, and Mississippi are better acquainted with their forest resources, by reason of forest surveys conducted in cooperation with the Forest Service. Taxation, now the most difficult problem in State forest work, is receiving thoughtful attention. At the unusually large and enthusiastic annual meeting of the Michigan Forestry Association, held at Saginaw in November, foresters from the Lake States and from Canada conferred on this and other questions, and in January a similar conference was held in New York. A study on the ground, to learn how present tax laws affect the profitableness of forest investments and how they are regarded by the people, has been inaugurated in New Hampshire by that State and the Forest Service in cooperation. If each of the States with a forest organization could contribute the figures of the stumpage for the State the work of securing a timber census of the whole country would be greatly simplified.

Some results of State forest work.

State.	Fire patrol.			Nurseries.	
	No. of wardens.	Annual expenditure.	Damage from fires in 1907.	Location.	Trees grown.
California	572	$5,500	$420,000		
Connecticut	400	464		Union tract, Tolland County.	White pine.
Hawaii	51			Nuuanu Station, Tantalus Forest.	Ironwood, blue gum (eucalyptus), black wattle, oak.
Indiana				Henrysville	Black locust, catalpa.
Kansas				Ogallah, Dodge City	Honey locust, Osage orange, catalpa, ash, elm.
Maine	250	2,000	5,830		
Massachusetts	320			Amherst	White pine, white ash.
Maryland	53	100	50,000		
Michigan				Roscommon	White, red, and western yellow pine, Norway and red spruce.
Minnesota	1,700	1,500	30,000	Pillsbury tract, Itasca State Park.	Norway spruce, white pine.
Mississippi				Agricultural College	Black locust, hickory, osage orange, catalpa, southern pines.
New Jersey	272	[a]3,513	11,647	Bass River tract	White pine.
New York	[b]746	7,500	9,610	Saranac Inn Station, State Fish Hatchery, Wawbeek, Axton.	White, Scotch, and red pine (nearly all promising species in small quantities).
Ohio				Wooster, Lancaster, Carpenter.	Catalpa, ash, yellow poplar, white pine, black locust, Norway spruce.
Pennsylvania	60	[c]	[d]	Greenwood, Huntingdon County; Asaph, Tioga County; Mont Alto, Franklin County.	White and Scotch pine, European larch, Norway spruce, balsam fir, hardwoods.
Rhode Island			15,000		
Vermont	[e]240		2,225	Burlington	White pine.
Washington	100	[f]9,424	54,600		
Wisconsin	308	1,500	[d]		

[a] $2,813 by the State; $700 by township.
[b] Town fire wardens, 133; district fire wardens, 613.
[c] Expenditure for patrol not segregated; appropriation for administration, $125,000; for land purchase, $250,000.
[d] Not yet compiled; in 1906, for Pennsylvania, $70,070.
[e] First selectman of each town.
[f] The expenditure in 1906 was $11,500, and the damage reported, $294,430.

Some results of State forest work—Continued.

State.	Number of trees in nursery.	Planting.			Area of State forests.
		Trees distributed in 1907.	Trees planted in State forests.	Total number of trees planted under direction of forester.	
					Acres.
California					3,800
Connecticut	1,000,000	300,000	50,000	400,000	1,400
Hawaii	30,000	20,100			397,687
Indiana	300,000		800,000		2,000
Kansas	179,500	[a] 83,964			
Maine					
Massachusetts	300,000	57,400			
Maryland					1,957
Michigan	2,000,000	65,000	150,000	650,000	39,000
Minnesota		[b]			42,800
Mississippi	50,000			26,000	
New Jersey	25,000		30,000	75,000	9,867
New York	[c] 1,674,750		450,000	2,633,100	1,548,450
Ohio	512,000	138,046		138,046	
Pennsylvania	2,388,800		[d]	215,000	761,000
Rhode Island				10,000	
Vermont	350,000	30,000			
Washington					
Wisconsin					300,000

[a] Distributed by station at Ogallah: The per cent living at the close of the year were honey locust, 68; osage, 66; catalpa, 73; ash, 68; elm, 80.

[b] Minnesota expends $20,000 annually in bounties for tree planting on prairie land.

[c] Four-year transplants, 470,350; 3-year-olds, 239,100; 2-year-olds, 65,300; 2-year-old seedlings, 640,000; 1-year-old seedlings. 860,000.

[d] Total number not at hand; number planted in 1907, 50,000.

During the year the State of Alabama created a forest commission, which has been organized and has begun work. The provisions of a new and excellent forest law are briefly stated under "Forest legislation" (p. 14). Of especial importance is the clause which provides for exemption from taxation for ten years of small areas which bear a young and growing stand of timber, provided the land is protected from forest fires. Bulletin 1, "Forestry and Forest Preservation in Alabama," has already been issued by the commission.

Prominent among the projects carried forward by the State forester of California was the publication of a comprehensive bulletin on the commercial production of eucalyptus. Preservative treatments of cedar, pine, and fir ties and poles, conducted in cooperation with the Forest Service at Los Angeles, showed that a 40-foot pole, worth $7.50, can be preserved with creosote at a cost of $2 so as to secure additional service worth several times the additional cost. The State fire patrol was materially strengthened.

In Connecticut 50,000 trees were planted in the Union forest, and fire lines were constructed. In the Portland forest 8,000 trees were planted and thinning was made. The State nursery has been increased to a capacity of a million trees, part of which will be ready for distribution at cost price to landowners this spring, and part two years later. In 1906 about 100,000 seedlings were furnished private owners, and in 1907 three and one-half times as many. Perhaps 1 per cent of the area of the State is owned by private parties or corporations now practicing at least crude methods of forestry. A forest survey of the State has been started. The forest-fire warden system has been developed and proved efficient in preventing fires. During the first year of the service, reports were received from 66 towns. In 35 of these 88 fires were reported, of which 64 were extinguished by the wardens and their assistants, at a total expense of $464.56, or an average of $7.25 per fire. The expense to the State was $116, to the counties $116, and to the 22 towns in which the fires occurred $232.28, or an average of $10.55 per town. Forty-five of these fires occurred in April and 25 in May, while the rest were scattered through the year.

Georgia's interest in forestry is manifest in the advancement of the course in forestry in the State University to a department, and in systematic educational work by the newly formed State forest association, which issues a publication, "Southern Woodlands." The result of a study of Georgia's forest resources, with maps, has been published.

Hawaii, early to take up forestry, conducts systematic practical work along two main lines—the maintenance of protection forests on important watersheds and the planting of waste and barren areas with useful trees. Lectures are given by the superintendent of forestry before the students of the College of Agriculture. An examination was made during 1907 of the forest back of Hilo, Hawaii, which it was found necessary to preserve as a protection to a watershed. It has been demonstrated that rubber grows well in Hawaii, and a large area will be planted with rubber trees, which afford a good forest protection to the land. A Hawaiian corporation has agreed to furnish an American railroad with 500,000 ohia cross-ties yearly for the next five years.

The State University of Illinois, at Urbana, has an interesting experimental plantation, and the State Normal School at De Kalb has established one more recently.

Among the varied activities of the Indiana forestry commission, none is more productive of better results than the encouragement of planting, by experiments conducted on the State reserve and by published information on forestry in general and on the success of those who are growing timber in Indiana.

In Iowa the professor of forestry at the State College carries on experiments and State work. Among the problems now under consideration are the improvement of planted groves and natural woodlots, the determination of what are the most valuable species for general woodlot planting, the best methods of planting and handling the woodlot, and the development of simple methods of preservative treatment which can be carried out economically by the farmer.

Since the establishment of the Fort Hays experiment station, in west central Kansas, a series of experiments has been started, in the very center of the Plains region, in growing young trees according to various cultural methods on upland and bottomland on a scale large enough to lend authoritativeness to the results. The State forestry stations at Ogallah and Dodge City are directing their chief efforts to the distribution of young trees in the westernmost counties.

Through cooperation between the State of Kentucky and the Forest Service, a study was made of the present timber supply of the eastern part of Kentucky, the rate of consumption, and other facts which would be of value in formulating a State forest policy.

Under the Louisiana forest law police jurors of the parishes (similar to county commissioners in other States) are also fire wardens. A campaign of education is being conducted to emphasize the necessity of preserving the forests. The absence of disastrous fires in 1907 is encouraging.

In Maine another year of comparatively light damage from forest fires gives additional testimony to the value of patrol. In the establishing and maintaining of lookout stations Maine has taken an advanced step, and present experience indicates that for successful control of fires the money can not be expended in a better way. Increased registration of forest students at the State University—a total of 45 students—is evidence that forestry is to have a much wider application in woodlot and timberland management. The junior class will plant 10,000 white pine seedlings this spring. Practical work is also gained in making thinnings in the university woodlot of 100 acres.

A State forest survey, conducted by the State forester in conjunction with the examination of timber tracts for private owners throughout the State, has awakened new interest in forest preservation in Maryland, and inquiries are met by the publication of circulars which deal with practical State problems. Arrangement has been made for a series of experiments in the preservative treatment of fence posts, to be carried on by the Maryland State experiment station in cooperation with the Forest Service. Fence posts of the kinds of wood which grow in commercial quantities in Maryland will be treated by different methods and set on the station grounds, where they will be subject to frequent inspection.

The State forester of Massachusetts issued, besides the annual report, the following publications: The Commonwealth of Massachusetts Forest Laws; Brief Instructions to Massachusetts Forest Wardens; How and When to Collect White Pine Seed; Forestry from the Commercial Standpoint; The Commercial Forest Trees in Massachusetts; The Study of Trees in Our Primary Schools; and Forest Laws Concerning Railroads. Forest-fire notices were printed and posted. An offer was made by the State forester to supply, for $1, express paid, 150 white pine and 150 white ash 2-year-old trees (Pl. LXV, fig. 1) for one-fourth acre planting in Massachusetts. The demand was so great that only half-orders could be filled. Schools were offered the following for $1: Twelve white pine seedlings, 2 years old; 24 white ash seedlings, 2 years old; 12 red spruce seedlings, 2 years old; 5 beech seedlings; one-half ounce of white pine seed; 12 chestnuts; 25 acorns; and 50 white ash seed. Sample plats have been established in all but four of the counties of the State, to study the yield and rate of growth of white pine. A State forest map has been prepared and an estimate made of the total forest areas, classified by types in each town and county. A study was made of the white pine blight.

In Michigan, during the fiscal year 1906–7, dead timber to the value of over $3,000 was sold from the State forest reserve. Over 60 miles of fire lines have been built. Owing to the efficiency of the fire patrol, no fires occurred this year. The plantations of the Saginaw forest farm, at Ann Arbor, are becoming a valuable object lesson, not only for school and experimental purposes, but for the general public. The Cleveland Cliffs Iron Company has increased its staff of foresters and is planning reforestation on a large scale. On the Ausable River, on Manitou Island, and at Cedar Lake landowners are carrying on extensive reforestation. Two investors at Grayling are purchasing lands and making preparations to convert these into regularly managed forest properties. The forestry commission distributed over 60,000 seedlings for experimental plantations among various landowners in the State. Forest sentiment among the people, among legislators, and with the press is steadily growing. One of the best illustrations was the enthusiastic meeting of the Northern Michigan Press Association at Traverse City, where an entire evening was devoted to forestry, and reforestation was strongly advocated.

The forest law of Minnesota of 1895 made town supervisors fire wardens under direction of a chief fire warden, who, among other duties, was required to make an annual report, including "important facts relating to forest interests." The annual appropriation to execute the law is $11,000. The legislature of 1907 placed Itasca State Park, at the headwaters of the Mississippi, under charge of the forestry board, appropriated $2,000 a year for demonstration work there and $1,500 for fire breaks, development, and improvements. It also appropriated $2,500 for planting on the Pillsbury Reserve the 3-year-old Norway spruce seedlings which the board had raised on that reserve. An area of 185 acres was thus planted at an expense of $6.50 per acre. In 1906 the board imported 20,000 white pine seedlings from Germany, which were planted the same spring on the Pillsbury Reserve.

During the fall of 1907 the Forest Service cooperated with the geological survey of Mississippi in an examination of cut-over longleaf pine lands. These lands are, with few exceptions, in wretched condition, because of recurring fires. Since they will not be needed for agriculture for many years, they should in the meantime be reproducing pine, to prolong an industry that means much to the State. In 1906 Mississippi ranked third in yellow pine production, cutting more than 1,500,000,000 board feet, or 13 per cent of the yellow pine cut. This business, with its attendant market for farm and other products, will soon be lost without fire prevention.

As a result of cooperative forest studies in the Ozark region of southern Missouri and western Arkansas, between the State of Missouri and lumber companies on the one hand and the Forest Service on the other, one large lumber company which controls in the aggregate four billion feet of standing timber has begun the application of forest management to its holdings.

Nebraska has begun to reap the fruits of early forest work, and the past year has manifested that many of the apparent failures of former years were in reality important lessons in the selection of proper species and methods of planting under peculiar conditions. The number of students in the different courses of forestry in the University of Nebraska shows a healthy growth. In addition to the regular courses a special course is given for public school teachers, and during the year a course for advanced students and courses of lectures on silvics and State forest policy have been inaugurated. The permanent equipment of the department of forestry has been enlarged, and now includes, among other additions, a forest herbarium, a large collection of wood specimens, and a portable sawmill for practical demonstrations upon the timber grown by provident farmers of that vicinity.

The forest survey of New Hampshire has not only made available information about the forests, but has greatly stimulated the practice of forestry. Dartmouth College now has a tract of 26,000 acres in the northern part of the State under forest management, and about 1,000,000 board feet a year are cut with care for reproduction. The water boards of Concord, Nashua, and Hanover are applying forest methods to tracts of 350, 700, and 1,000 acres, respectively. Sixty plantations of white pine have been made, one of them, at Manchester, comprising 25 acres. As an experiment, 240 acres at Winchester have been sowed by the broadcast and the spot methods.

During the past year New Jersey has developed a definite policy. The forest commission is actively working for the betterment of the woodlands of the State, to establish values in forest lands, and to make them continuously productive. The means employed are control of forest fires and instruction of woodlot owners. The State contains numerous forest areas of considerable size, but for the most part the work concerns itself with the intensive management of woodlots for the production of ties and lumber for nearby markets. During the one year of its operation the fire service has succeeded in reducing the acreage burned and the damage done to woodlands to less than one-tenth that of any former year. This has already affected

favorably the market price of forest property. The commission has acquired about 11,000 acres of land for State reserves, and will develop the property as demonstration areas and public parks. It recognizes, however, that the private owner has, and will continue to have, the greatest interest in this question, and will, therefore, devote every effort to make such lands valuable and productive.

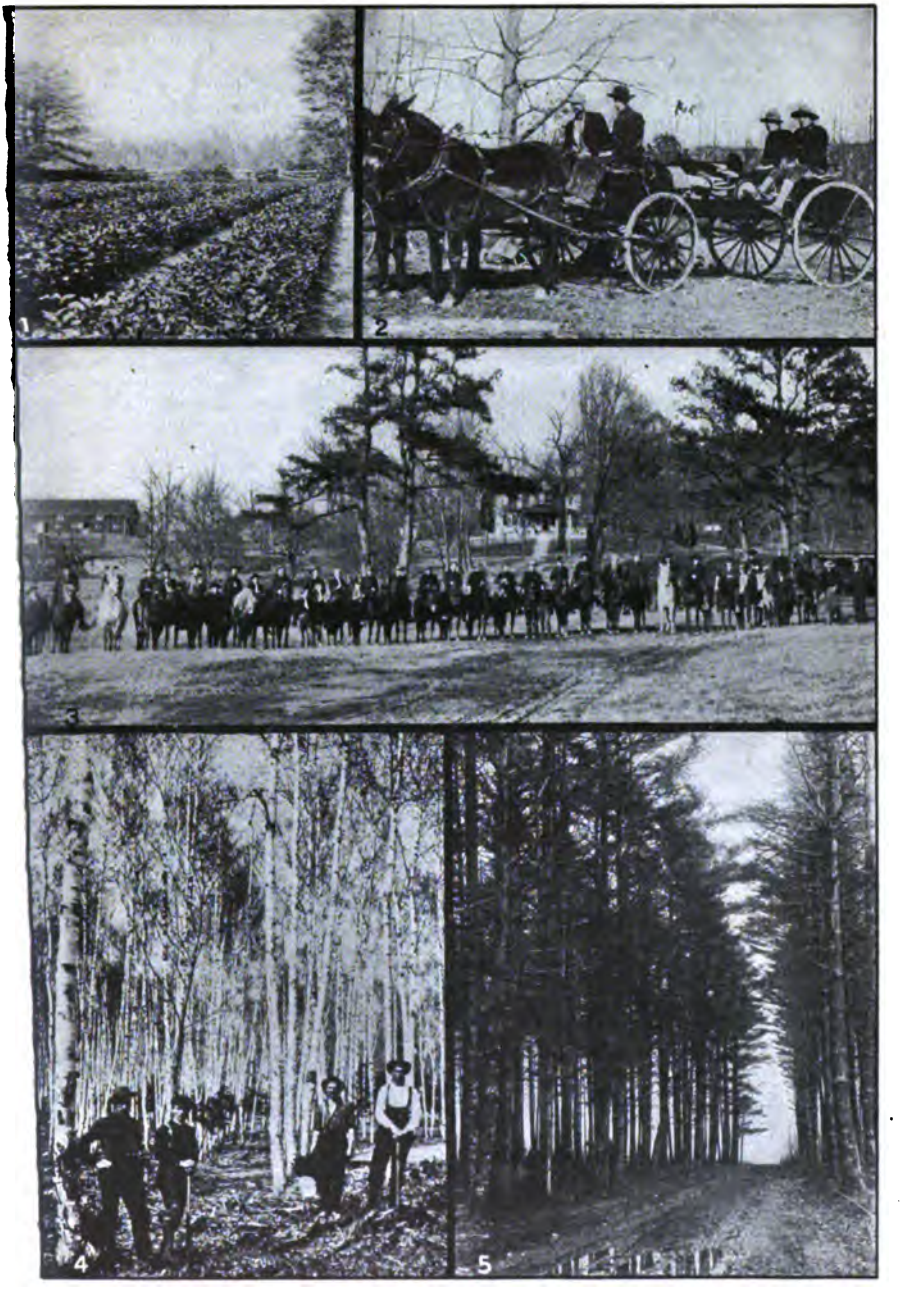
The New York State nurseries, in April and May, 1907, contained 549,450 4-year-old transplants of white pine, Norway pine, Scotch pine, Norway spruce, and European larch, ready for planting. In addition, an importation has been made from Germany to complete an even million trees, to be set out this spring. A crew of 100 men, under the charge of two professional foresters, will do the work (Pl. LXV, fig. 4). A 10-acre nursery will be established in central New York for propagating stock for free distribution and to furnish shade trees for the good-roads system. A new feature is the creation of a patrol of the Adirondack railroads during the spring months. This contemplates a force of 100 men, distributed along the steep railroad grades and at places in the forest where conditions are the most dangerous. The railroad patrol is entirely separate from the fire-warden system, the patrols being paid directly from the Albany office. At the end of the year the railroads refund to the State one-half the expense. During the summer of 1907 seed-spot sowing was carried on, and a field experiment station started. Fifteen species of seeds have been planted in various ways. The most hopeful experiment is one in which seed is dropped on the unbroken ground at 5-foot intervals, and the seed at each spot covered with a handful of sand. Western yellow pine seed planted in this way produced trees in nearly every spot. An experiment was made with white pine by putting a handful of black muck on the unbroken ground, placing a few seeds in the muck, and covering the seed with sand.

During the past year forest work in North Carolina has been confined to the swamp lands near the coast, which are owned by the State board of education. After an examination most of these forest lands were withdrawn from sale until it could be definitely determined whether it is better to sell the land outright, to sell the timber on the stump and have it cut under the supervision of a forester, or to sell all the timber and clear the land for agricultural purposes. In a number of cases it is evidently the better policy to keep the forests and make them a perpetual source of income to the State. These examinations have also encouraged the drainage of swamp lands, especially a 44,000-acre tract which belongs to the State, part of which is good forest land. A forester has been employed, who will carry out plans regarding the State lands and take up questions regarding general State forestry. The State owns 700,000 acres of forest land, and its forest interests are second only to those of agriculture.

A very successful plan in Ohio of cooperating with landowners in establishing plantations and maintaining their timber tracts in such condition that they will serve as educational examples in correct forest practice has been extended until practically every county in the State has been covered. This includes the preparation of plans for managing woodlots and timber tracts and the furnishing of planting material which will be grown according to plans and instructions furnished. A total of 466 farmers are thus cooperating with the State experiment station. A State forest survey has been begun.

The Pennsylvania department of forestry has during the past year directed most of its attention and energy to the acquiring of new land, the establishing of good nurseries, and the pushing of reforestation work. The State now holds in forest reserve lands about 10 per cent of the area of timberland of the Commonwealth. The nursery area has been increased to over 12 acres, and in another year the number of seedlings will be more than doubled. There are at present, in three nurseries, a total number of 2,250,000 seedlings, of which about 8 per cent are hardwoods, the remainder being conifers, mostly white pine. The reserves are being improved and roads are being opened and built in order to make the land accessible and to serve as fire lines. Special attention is paid to the control of forest fires, and losses are very greatly decreasing (Pl. LXV, figs. 2 and 3). Fire-killed timber is utilized. A successful experiment with small fire-killed timber was made some time ago in the burning of charcoal. A forest academy is maintained directly by the Department for the training and education in forestry of young men of the State for work on the forest reserves, and to speak to public schools, teachers' institutes, and farmers' institutes. The school has made wonderful development and has now under construction a new and thoroughly modern red stone building to be used for dormitory and lecture rooms, together with thoroughly equipped laboratories.

The second annual report of the State forester of Rhode Island discusses general forest conditions, methods of lumbering, stumpage prices, and the problems of forest taxation and fires. The report states that the 250,000 acres of unimproved land of the



FIRE PATROL AND SILVICULTURE IN STATE FOREST WORK.

1. Beds of white ash seedlings, ready for distribution, in the Massachusetts State Nursery. 2. Fire wagon, the latest equipment for fighting forest fires in Pennsylvania. 3. Students of the Pennsylvania State Forest Academy responding to a fire call; an important part of the training is to learn the surest and quickest methods of extinguishing forest fires. 4. Underplanting white birch with pine and spruce seedlings in the Adirondack Preserve. 5. Possibilities of second growth in New England; white pine, 50 years old, recently thinned with a profit of $44.32 per acre under the direction of the Connecticut State forester.

State should yield 40,000,000 board feet of lumber and 125,000 cords of fuel per annum worth $1,175,000. The present income from this source, according to the State census of 1905, is $697,593. Landowners have applied for advice in the management of woodland aggregating 2,250 acres.

The State experiment station of Vermont issued a bulletin entitled "Forest Planting in Vermont," which will greatly promote the practice of forestry. The State nursery has been increased in capacity for supplying plant material to farmers in the State and to avoid delay while stock is growing here seedlings have been secured from the New York State nurseries.

The progress of forest work in Washington for the past year is especially marked by increased activity on the part of the State and owners of timberlands to protect the timber from fire, the inauguration of forest instruction at the University and at the Agricultural College at Pullman, and the better appreciation by the people of the National forest policy. The work of the deputy fire wardens in the several counties of the State entirely prevented destructive timber fires. About one hundred forest rangers were appointed, usually at the request of mill men and timberland owners by whom they were employed. At a meeting of prominent lumbermen in Seattle a ranger service was organized for the fire season of 1908. This organization represents some 4,000,000 acres of timberland, and it is the plan to assess holdings at the rate of 1 cent an acre for fire protection. Other timber holders of the State are doing something in the same line. One company, for example, has a force of men in the field which is as effective as the State force.

The West Virginia State Board of Trade has appointed a committee to investigate State forest conditions and recommend to the State legislature the enactment of laws which will promote forest preservation.

During 1907 the most important forest work in Wisconsin was the appraising and selling of scattered and agricultural lands and the use of the proceeds to purchase other lands suitable only for forestry, so as to consolidate the main forest reserves on the headwaters of the Wisconsin and Chippewa rivers. About 15,000 acres have recently been purchased. Concessions have been granted private capitalists to store water at the headwaters of streams, the promoters to reap benefit from the sale of waterpower. Much interest centers in this attempt of private capital to establish reservoirs which will operate in conjunction with the forest cover in the regulation of streams.

FOREST LEGISLATION.

More new and amendatory forest legislation was enacted by the State legislative assemblies from December 1, 1906, to December 1, 1907, than during any previous year. The following is a brief summary of the laws passed by Congress and the State legislatures during that period:

United States.—Salary of the Forester increased from $3,500 to $5,000 per annum (34 Stat., 1269); $100,000 appropriated to continue surveys of National Forests (34 Stat., 1336); $25,000 for Appalachian and White Mountain survey and report (34 Stat., 1281); Forest reserves to be known hereafter as National Forests (34 Stat., 1269); Forest reserve special fund abolished, and annual appropriation for National Forests increased from $900,000 to $1,900,000 as compensation; payment of expenses incurred for protection and care of fish and game supplied to stock National Forests was authorized; purchase of technical books and journals for officers outside of Washington authorized (34 Stat., 1270); creation of new and additions to existing National Forests in Oregon, Washington, Idaho, Montana, Colorado, or Wyoming forbidden, except by act of Congress (34 Stat., 1271); certain townships in Black Hills National Forest placed within operation of agricultural settlement act of June 11, 1906 (act of February 8, 1907, 34 Stat., 883); certain National Forest lands granted to the cities of Durango, Colo. (34 Stat., 1053), and Boulder, Colo. (34 Stat., 1223), for water-supply purposes.

Alabama.—State commission of forestry created, to serve without compensation or expense to the State; governor authorized, upon recommendation of commission of forestry, to accept gifts to State of lands to be administered as State forest reserves; commission to investigate and report annually on forest conditions and recommend legislation; county game and fish wardens declared forest wardens with authority of peace officers, and all peace officers ex officio forest wardens; appointment of deputy forest wardens without compensation authorized; owners of land not exceeding assessed value of $5 per acre allowed to contract with commission of forestry to plant and protect timber trees on such land, and secure its exemption from taxes for ten years. Counties authorized to appropriate $250 annually as salary for their forest warden; provisions enacted against setting and spread of fires, use of engines without spark arresters, and attaching electric wires to, or, without consent of mayor, mutilating

trees along streets; moneys received as penalties and from State forest reserves to constitute forest reserve funds, available for forest administration; $500 annually appropriated; consent of State given to acquisition by the United States of land for a National Forest (act approved November 30, 1907).

California.—Substance of Penal Code, sections 384, 384a, and 384b, incorporated in and enlarged upon by amendment of section 384; stringent regulations against setting and spread of fires, use of engines without spark arresters, and blasting wood during "dry season" without permit from State or district fire warden; rendering assistance to fire warden made compulsory; one-half of fines to be paid to forest fund (ch. 536, laws of 1907); $5,000 appropriated (ch. 177, laws of 1907), to be expended under direction of State department of engineering (ch. 183, sec. 13, laws of 1907) in cooperation with United States Forest Service in construction of fire lanes and trails for protection of the south slope of the San Bernardino Mountains.

Connecticut.—Section 1221, general statutes, amended to increase surrounding space, which must be cleared before a fire is started (ch. 43, laws of 1907); sections 3, 4, and 5, chapter 238, public acts of 1905, amended, making fire chiefs in consolidated town and city governments ex officio fire wardens and improving fire regulations (ch. 136, laws of 1907).

Florida.—Cutting, removing, or working in any manner for turpentine purposes any timber forbidden under penalty of fine or imprisonment or both when any tax-sale certificates are outstanding and unredeemed against the land or timber or the turpentine privileges on such lands (ch. 5683). Approved June 3, 1907. Penalty for unauthorized, willful cutting, scraping, destroying, or injuring of standing trees, title to which is in another, made the same as for theft of personal property of equal value (ch. 90, laws of 1907).

Idaho.—Sections 10, 11, 12, and 13 of House bill 131 (laws of 1905, p. 145) repealed; provision made for division of State into fire districts, and appointment, with police powers, of district fire wardens to be paid by property owners requesting such appointment; a "close season" and stringent and comprehensive fire regulations established; clearing of railroad rights of way required; posting of fire laws and regulations provided (H. B. 61, session laws of 1907, p. 18).

Indiana.—Granting of rights of way over State forest reservation, laboratory of forest demonstration, and nurseries, to railroad, telegraph, and telephone companies provided (ch. 57, laws of 1907).

Kansas.—Appointment of two commissioners of forestry, each to be in charge of one of the two State forest experiment stations, provided for. Duty of each commissioner to devote entire time to improvement of his forestry station and to investigation and experiment; to furnish seedlings free to residents of the State; to disseminate information, and upon petition of 25 persons to hold meetings in any county. Expenses and salary of $1,000; $5,600 per year appropriated (ch. 405, laws of 1907).

Maine.—Specification 10, section 6, chapter 9, revised statutes (forest land exemption), amended to exempt from taxes, under certain conditions, such timber lands *hereafter* planted and cultivated (ch. 169, laws of 1907).

Massachusetts.—Salary of State forester increased from $2,000 to $3,000; new provisions as to his expenditures (ch. 473, laws of 1907); sections 16 and 20, chapter 32, revised statutes, amended; sections 17, 18, and 22, chapter 32, and section 14, chapter 53, repealed; appointment of forest wardens in cities and towns provided for, and expenditure of $2,000 annually on forest warden conventions, including traveling expenses of wardens, authorized (ch. 475, laws of 1907); commissioners on fisheries and game given power to arrest those found unlawfully setting fire (ch. 299, laws of 1907).

Michigan.—Office of State game, fish, and forestry warden created, with combined duties of game and fish warden, commissioner of State land office as forest commissioner, and chief fire warden; salary of $3,000 and expenses (act 106, laws of 1907); special commission of inquiry on tax lands, forestry, forest fires, and forest legislation created, expenses paid, no salary (act 188, laws of 1907); fire warden law of 1903 repealed; new act providing township supervisors to be fire wardens; not exceeding 10 district deputy game, fish, and forestry wardens, with $1.000 salary, police power in enforcing fire laws, and power to employ assistance (act 317, laws of 1907); lands of State agricultural College in Iosco and Alcono counties withdrawn as forest reserve (act 299, laws of 1907).

Minnesota.—Section 2205, revised laws of 1905, amended; governor ex officio member of State forestry board (ch. 171, laws of 1907); $2,500 appropriated for planting evergreens on Pillsbury Reserve, Cass County (ch. 351, laws of 1907); Itasca State park made a forest reserve under State forestry board; $2.000 appropriated for demonstration work on said reserve, and $1 500 for fire breaks and other improvements; board of regents of State University authorized to undertake forestry work in conjunction with State forestry board (ch. 90, laws of 1907).

Montana.—State game and fish warden and deputies made ex-officio State fire warden and deputies with duty to protect the timber within the State and especially that owned by the State from fire. May employ men in emergencies and incur necessary expenses. Authority to arrest for violation of fire laws (ch. 147, laws of 1907).

New Jersey.—State board of forest park reservation commissioners authorized to change fire districts and appoint wardens at joint expense of State and townships (ch. 9, laws of 1907); to acquire certain lands as part of State forest park reservation and make rules and regulations (ch. 143, laws of 1907).

New York.—Section 229, forest, fish, and game law of 1900, as amended by chapter 186, laws of 1903 (fire penalty), further amended by reducing minimum penalty (ch. 667, laws of 1907).

Oregon.—A nonpartisan State board of forestry created to investigate forest conditions, suggest legislation, and supervise and give publicity to matters pertaining to forestry; may incur $500 expenses, but receive no compensation; property owners willing to pay forest wardens may secure appointment of citizens as such; State and county officials and resident officers of National Forests may be appointed ex officio forest wardens; a "close season" established, during which fire can not, except under special precautions and subject to special liability, be used without permit from State fire warden; permits contain restrictions and are revocable for cause; stringent legislation enacted against setting and spread of fire; use of spark arresters and clearing of railroad rights of way required; chapter 227, general laws of 1905, repealed (ch. 1, laws of 1907).

Pennsylvania.—Constables and employees of department of forestry made fire wardens with power to compel assistance; two-thirds of compensation and expenses to be repaid to the county by the State; $40,000 appropriated by the State (ch. 9, laws of 1907); special provisions for protection of forest lands containing oil and gas wells (ch. 334, laws of 1907).

Rhode Island.—Allowance for traveling expenses of commissioner of forestry, together with cost of printing and supplies, reduced from $500 to $300 (ch. 1465, laws of 1907).

Tennessee.—Duties of department of game, fish, and forestry, respecting trespass, forestry, and forest fires, defined; special provisions against trespass and spread of fire by engines and charcoal burners; certain lands may be donated to State for forestry purposes; forest policy outlined; cooperative investigation with United States Forest Service authorized. Wardens authorized to summon emergency help for fighting fires; misdemeanor to disobey summons; $3 per day allowed for such compulsory service (ch. 397, laws of 1907).

Vermont.—Provisional appropriation of $500 per year for five years to aid Vermont agricultural experiment station in establishment and maintenance of nursery for forest seedlings; material for planting to be furnished at cost within State, and skilled assistance provided (ch. 15, laws of 1906, approved December 16, 1906).

Washington.—Annual salary of State fire warden and forester increased from $1,500 to $2,000 (ch. 201, laws of 1907).

Wisconsin.—Tax exemptions provided for certain lands devoted to forest culture (ch. 592, laws of 1907); State board of forestry authorized to appraise, preparatory to selling to United States, all State lands and timber within Indian reservations; moneys from such sales, except when otherwise disposed of by constitution, to be expended only in purchase of State forest reserves (ch. 96, laws of 1907); State may purchase lands north of town 33; $10,000 per annum appropriated (ch. 491, laws of 1907); State park board created, to work in conjunction with director of State geological survey and State forester; $500 appropriated (ch. 495, laws of 1907); in granting private corporation privilege to dam and improve Wisconsin River, certain supervision and control over its operations given State board of forestry (ch. 335, laws of 1907).

Wyoming.—Misdemeanor to light and leave fire in any woods or prairies without extinguishing (ch. 22, laws of 1907).

NATIONAL FOREST OFFICERS.

Gifford Pinchot, Forester, Washington, D. C.; Overton W. Price, Associate Forester, Washington, D. C.

STATE FOREST OFFICERS.

State or Territory.	Name and post-office.	Official position.
Alabama	John Wallace, jr., Montgomery	Secretary, State forest commission.
California	Gerard B. Lull, Sacramento	State forester.
Connecticut	Austin F. Hawes, New Haven	Do.
Hawaii	Ralph S. Hosmer	Superintendent of forestry.
Indiana	W. H. Freeman, Indianapolis	Secretary, State board of forestry.
Kansas	Henry Cooper, Dodge City	Commissioner of forestry.
	F. H. Ridgway, Ogallah	Do.
Kentucky	Hubert Vreeland, Frankfort	Chairman, State board of agriculture, forestry, and immigration.
Louisiana	A. W. Crandell, Baton Rouge	State forest commissioner.
Maine	Edgar E. Ring, Augusta	Land agent and forest commissioner.
Massachusetts	F. Wm. Rane, Boston	State forester.
Maryland	F. W. Besley, Baltimore	Do.
Michigan	Wm. H. Rose, Lansing	Secretary, forestry commission.
	Filibert Roth, Ann Arbor	State forest warden.
Minnesota	Gen. C. C. Andrews, St. Paul	Secretary, State forestry board, and forestry commissioner.
Mississippi	A. F. Crider, Biloxi	Director, State geological survey.
New Hampshire	R. E. Faulkner, Keene	Secretary, forest commission.
New Jersey	Alfred Gaskill, Trenton	Secretary, forest park reservation commission, and forester.
New York	Wm. F. Fox, Albany	Superintendent of State forests.
	C. R. Pettis	Forester.
North Carolina	Joseph H. Pratt, Chapel Hill	State geologist.
Ohio	Charles E. Thorne, Wooster	Director, State agricultural experiment station.
Oregon	J. W. Baker, Cottage Grove	Forestry, fish, and game warden.
	E. P. Sheldon, Portland	Secretary, forestry commission.
Pennsylvania	Robert S. Conklin, Harrisburg	Commissioner of forestry.
	George H. Wirt, Harrisburg	State forester.
	J. P. Wentling, Mont Alto	Forester.
Rhode Island	Jesse D. Mowry, Chepatchet	Commissioner of forestry.
Tennessee	C. A. Keffer, Knoxville	Secretary, Tennessee forest commission.
Vermont	Arthur M. Vaughn, Randolph	Commissioner of forestry.
Washington	R. W. Condon, Port Gamble	Chairman, department of forestry.
	J. R. Welty, Olympia	State fire warden and forester.
West Virginia	I. C. White, Morgantown	Superintendent, geologic and economic survey.
Wisconsin	Edward M. Griffith, Madison	State forester.

FOREST ASSOCIATIONS.

American Forestry Association.—President, Hon. James Wilson, Secretary of Agriculture; secretary, Thomas E. Will, Washington, D. C.; treasurer, Otto Luebkert, Washington, D. C.

The Appalachian National Forest Association.—President, D. A. Tompkins, Charlotte, N. C.; secretary and treasurer, John H. Finney, Washington, D. C.

International Society of Arboriculture.—President, Gen. William J. Palmer, Colorado Springs, Colo.; vice-president, Henry John Elwes, F. R. S., Colesborne, Cheltenham, England; secretary, J. P. Brown, Connersville, Ind.

Society of American Foresters.—President, Gifford Pinchot, Washington, D. C.; secretary, W. F. Sherfesee, Washington, D. C.

State organizations.

Name of organization.	Secretary.	Address.
Appalachian Mountain Club	R. B. Lawrence	Tremont Bldg., Boston.
Arizona Salt River Valley Water Users' Association.	Chas. A. Van der Veer	Phoenix, Ariz.
California:		
Water and Forest Association	T. C. Friedlander	45 Mills Bldg., San Francisco.
Forestry Educational Association	E. C. Damon	San Diego.
Sierra Club	William E. Colby	San Francisco.
Forest and Water Society of Southern California.	Wm. H. Knight	Los Angeles.
Pacific Coast Forest, Fish, and Game Association.	Wm. Greer Harrison	San Francisco.
Tri-Counties Reforestation Committee.	L. A. Finch	Riverside.
Cincinnati Forest and Improvement Association.	Adolph Leue	127 West Twelfth st.
Colorado Forestry Association	W. G. M. Stone, president	Denver.

State organizations—Continued.

Name of organization.	Secretary.	Address.
Connecticut Forestry Association	Miss Mary Winslow	Weatogue.
Georgia Forestry Association	Alfred Akerman	Athens.
Iowa Park and Forestry Association	Wesley Greene	Des Moines.
Maine Forestry Association	E. E. Ring	Augusta.
Massachusetts Forestry Association	Edwin A. Start	4 Joy st., Boston.
Michigan Forestry Association	J. Fred Baker	East Lansing.
Minnesota State Forest Association	E. G. Cheyney	St. Anthony Park.
Nebraska Park and Forestry Association	L. B. Craig	York.
New England Forest, Fish, and Game Association.	Walter L. Hill	Pierce Building, Boston.
New Hampshire Society for the Protection of New Hampshire Forests.	Allen Hollis	Concord.
New York:		
State Fish, Game, and Forest League	John D. Whish	Capitol, Albany.
Forestry, Water Storage, and Manufacturing Association of the State of New York.	John C. Durgin	1 Broadway, New York.
Association for the Protection of the Adirondacks.	E. H. Hall	Tribune Bldg., New York.
Northern New York Forestry Association.	O. B. Tappan, director	Potsdam.
American Forest Preservation Society.	George Milroy Bailey	Corfu, N. Y.
North Dakota State Sylvaton Society	Miss Ella J. Mitchell	Penn, N. Dak.
Ohio State Forestry Society	C. W. Waid	Wooster.
Oregon Forestry Association	A. D. Monteith	Portland.
Pennsylvania Forestry Association	F. L. Bitler	1012 Walnut st., Philadelphia, Pa.
Pennsylvania Franklin Forestry Society	W. G. Bowers	Chambersburg.
Vermont Forestry Association	Ernest Hitchkock	Pittsford.
Washington Forestry Association	Edmund S. Meany	Seattle.
West Virginia Forestry Association	A. W. Nolan	Morgantown.

SCHOOLS OF FORESTRY.

Post-Graduate Schools.

Yale University, Forest School, New Haven, Conn.—A two years' post-graduate course, leading to the degree of Master of Forestry. Under the direction of the officers of the Yale Forest School, a two months' summer course, July and August, is conducted at Milford, Pike County, Pa. Prof. Henry S. Graves, Director.

University of Michigan, Forest School (part of the general Department of Literature, Science, and the Arts), Ann Arbor, Mich.—A two years' post graduate course, leading to the degree of Master of Science in Forestry. A six weeks' summer course, in July and August, is conducted on the State reserve at Roscommon. Prof. Filibert Roth, Professor of Forestry.

Harvard University, Forest School, Cambridge, Mass.—A two years' graduate course, in connection with the Graduate School of Applied Science. Prof. R. T. Fisher, in charge of curriculum.

Undergraduate Schools.

Biltmore Forest School, Biltmore, N. C.—Course covers one full year, leading to the degree of Bachelor of Forestry, and, with two years of practical forest work, the degree of Forest Engineer. Dr. C. A. Schenck, Director.

University of Minnesota, School of Forestry, St. Anthony Park, Minn.—A four years' undergraduate course, leading to the degree of Bachelor of Science in Forestry. A six weeks' summer course, in July and August, is conducted at the Itasca State Forest. Prof. Samuel B. Green, Professor of Forestry.

University of Nebraska, Department of Forestry, Lincoln, Nebr.—A four years' undergraduate course, leading to the degree of Bachelor of Science. Frank J. Phillips, Professor of Forestry.

Michigan State Agricultural College, Department of Forestry, East Lansing, Mich.—A four years' undergraduate course, leading to the degree of Bachelor of Science. J. Fred Baker, Professor of Forestry.

Pennsylvania State College, Forest School, State College, Pa.—A four years' undergraduate course, in connection with the State Department of Agriculture, leading to the degree of Bachelor of Science. Hugh P. Baker, Professor of Forestry.

University of Washington, School of Forestry, Seattle, Wash.—A four years' undergraduate course leading to the degree of Bachelor of Science in Forestry. Frank J. Miller, Professor of Forestry.

University of Georgia, Department of Forestry, Athens, Ga.—A four years' undergraduate course, leading to the degree of Bachelor of Science in Forestry. Alfred Akerman, Professor of Forestry.

Colorado School of Forestry, Colorado Springs, Colo.—A three years' undergraduate course, leading to the degree of Bachelor of Forestry. No entrance requirements. A summer course is conducted at Manitou Park from July 15 to September 15.

The Mont Alto Forest Academy, Mont Alto, Pa.—Maintained by the Pennsylvania Department of Forestry for the training of young men of the State for work on the State forest reserves. Geo. H. Wirt and J. P. Wentling, in charge of forest courses.

Courses in forestry are now given at the University of Maine, Orono, Me., Gordon E. Tower, in charge; Iowa State College, Ames, Iowa, Chas. A. Scott, in charge; Mississippi Agricultural and Mechanical College, Agricultural College, Miss., Geo. L. Clothier, in charge; Purdue University, Lafayette, Ind., Prof. Stanley M. Coulter, in charge; Berea College, Berea, Ky., W. L. Flanery, in charge; State College of Washington, Pullman, Wash., E. O. Siecke, in charge; Winona Agricultural Institute, Winona Lake, Ind., W. R. Eastman, in charge; North Dakota School of Forestry, Bottineau, N. Dak., J. Allen Kemp, president.

A course of lectures is given annually at the Massachusetts State Agricultural College, Amherst, by Prof. Frank Wm. Rane, State Forester of Massachusetts; at the Maryland Agricultural College, College Park, by Fred W. Besley, State Forester of Maryland; at the University of Wisconsin, Madison, by Edward M. Griffith, State Forester of Wisconsin; at the Agricultural College of Utah, Logan, by W. W. Clark; at the Connecticut Agricultural College, Storrs; and at the State Agricultural College of Colorado, Fort Collins.

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PROGRESS OF FORESTRY IN 1904.

BY

QUINCY R. CRAFT,

Editorial Clerk, Bureau of Forestry.

[REPRINT FROM APPENDIX, YEARBOOK OF DEPARTMENT OF AGRICULTURE FOR 1904.]

[Reprint from Appendix, Yearbook of Department of Agriculture for 1904.]

PROGRESS OF FORESTRY IN 1904.

By Q. R. Crafts, *Editorial Clerk, Bureau of Forestry.*

The year 1904 saw a large gain in the popular acceptance and application of the principles which govern the proper care and use of woodlands. Many landowners and great lumber concerns now realize that conservative forest management means actual gains to them in dollars and cents; and western stockmen and miners no longer doubt that regulation of grazing and cutting timber on the reserves is necessary for the perpetuation of their industries. Forest work carried on by the Federal Government in conjunction with the States was rich in results. State forest departments

tigations and experiments, in the knowledge gained of actual conditions and needs in the reserve regions of the West, and in the preparation and installation of working plans upon forest lands.

The remarkable advance of forestry during recent years was fittingly marked by a forest congress extending through four days of the first week in January, 1905. This meeting far exceeded in size and importance any similar gathering that has been held in America. The lumbering, mining, grazing, and woodworking industries, the railroads, and the interests of irrigation in the West were represented by men of the highest professional and business standing and of national reputation. In conference with these men were the official representatives of many States and of the Canadian and Philippine forest services.

FOREST RESERVE POLICY MORE CLEARLY UNDERSTOOD.

Careful consideration of the needs of the industries which use the products of the forest reserves, and of the requirements necessary to preserve the public forests permanently, is leading to a national policy concerning the Federal forest reserves. The prime purpose in establishing these reserves is to prevent fires, wasteful lumbering, and overgrazing, and at the same time to secure the fullest possible use of their productive capacity. Often their most important service is to guard the forested mountains and hillsides from which the streams flow, for water is the first need of the arid States; but the interests of the miners, who can not operate without heavy supplies of timber, and of the stockmen dependent upon the public range, must also be recognized.

In 1904 seven new forest reserves were created—Baker City, in Oregon; Cave Hills and Slim Buttes, in South Dakota; Grantsville and Salt Lake, in Utah; and Warner Mountains and Modoc, in California. Additions were made to the Fish Lake (Utah), the South Platte (Colorado), and the Big Horn (Wyoming) reserves. Several areas, having a total of 1,054,342 acres, which examination had shown to be better suited for agriculture than for forestry, were restored to the public domain, so that the net increase in the area of the reserves was but 149,035 acres.

Changes in boundaries during 1904 and present area of Federal forest reserves.

States and Territories.	Number of forest reserves.	Area of reserves created in 1904.	Area added in 1904.	Lands unsuited eliminated in 1904.	Area of reserves, Dec. 31, 1904.
		Acres.	*Acres.*	*Acres.*	*Acres.*
Alaska	2	.....	.....	.....	4,909,880
Arizona	8	.....	.....	.....	6,740,410
California	10	594,736	.....	320	9,427,154
Colorado	6	.....	3,681	237,182	2,874,439
Idaho	[a]3	.....	.....	57,600	3,989,480
Montana	[b]7	.....	45,440	127,360	7,964,640
Nebraska	2	.....	.....	.....	208,902
New Mexico	3	.....	.....	.....	3,257,920
Oklahoma	1	.....	.....	.....	57,120
Oregon	4	52,480	.....	.....	4,637,560
Porto Rico	1	.....	.....	.....	65,960
South Dakota	[c]3	81,520	.....	.....	1,244,840
Utah	8	164,400	131,200	.....	2,756,280
Washington	[a]4	.....	.....	.....	7,024,760
Wyoming	[d]4	.....	129,920	631,880	8,199,624
Total	[e]62	893,136	310,241	1,054,342	63,358,959

[a] The Priest River Reserve is situated jointly in Idaho (541,160 acres) and Washington (103,960 acres).
[b] The Bitter Root Reserve is situated jointly in Montana (621,200 acres) and Idaho (3,398,400 acres).
[c] The Black Hills Reserve is situated jointly in South Dakota (1,163,320 acres) and Wyoming (46,440 acres).
[d] The Yellowstone Reserve is situated jointly in Wyoming (6,580,920 acres) and Montana (1,229,680 acres).
[e] Four of the reserves are enumerated twice (see *a*, *b*, *c*, and *d*), so that the total number is 62.

A GAIN OF SIGNIFICANT IMPORTANCE.

It is an achievement of no small moment that the public generally has been led to regard forestry as something tangible and helpful. The adoption of forest management is now regarded as vitally necessary for the continuance of the manifold industries for which forest products are essential, and for the supply of many needs of everyday life. The desire of many landowners to secure for their forest holdings the best care is indicated by the numerous inquiries and requests for assistance received by the Bureau of Forestry. Applications for assistance are now on file covering an area of no less than 8,000,000 acres, for three-fourths of which preliminary examinations have been made. Detailed working plans have been completed for over 1,000,000 acres of these lands. Twenty thousand acres in woodlots and 500,000 acres in timber tracts are under management. That working plans are now in preparation for an area aggregating 3,500,000 acres shows how fast this work is growing. Private enterprises are beginning to take advantage of the examples furnished by the Government, and are employing trained foresters to carry out their own plans of management.

LARGE OPPORTUNITIES IN THE SOUTH.

The possibilities of forest management on the forest lands in the South have been clearly shown in several large working plans recently finished and put into practice by the owners. There the cheapness of labor and favorable natural conditions permit more careful logging methods and more complete utilization of material than are possible in certain other sections, and the longer growing season and the relative nearness to markets offer peculiar advantages for conservative lumbering with a view to future crops. The interest of northern and eastern lumbermen is turning more and more to the hardwoods found in that region. The diversity of species that compose those hardwood forests, and the increasing utility of many of them, together with the rapid increase in their value, are leading their owners to inquire about the means of removing material that is now marketable, without destroying that which may be valuable in the future. Nowhere is the opportunity for conservative forest management more promising than in some parts of that great region.

AN EXAMPLE IN THE LUMBERING OF WHITE AND RED PINE.

The success that has attended the sale and removal of timber from the Chippewa Indian lands in northern Minnesota, selected to constitute the Minnesota National Forest Reserve, has done much to establish the practicability of conservative lumbering of white and red pine in that region. Although the timber is to be removed under regulations prescribed by the Forester of the Department of Agriculture, and although 5 per cent of the timber on the area to be lumbered is reserved to provide for reproduction (Pl. LXXV, fig. 1), the stumpage price obtained at public sale was the largest that had ever been realized for similar timber in the same region. When the present utterly waste condition of vast areas in the Lake States formerly covered with valuable pine forests is considered, the demonstrated possibility that such timber can be cut and removed profitably, under restrictions intended to secure forest renewal and reduce the danger from fire to the minimum, is one of large hopefulness.

SOME PRACTICAL INVESTIGATIONS OF THE BUREAU OF FORESTRY.

The new system of turpentining, by the use of cups and gutters, which gives a greatly increased product of turpentine and uniformly higher grades of rosin, with far less damage to the trees, fulfills its early promise of increased profits and extended life for the naval stores industry (Pl. LXXV, fig. 5). In consequence, the destructive method of boxing trees for turpentine has been abandoned by the larger and more progressive operators, while the improved method of turpentining has extended rapidly during the year. As a further service the Bureau now has in progress an entirely new line of field experiments which look to a very considerable lessening of the tapping wound now made in the trees.

The condition of the basket willow industry has been studied, and several exceedingly important plans for its improvement are outlined in a bulletin. These improvements will secure the highest grades of home-grown willow through more scientific methods of culture. A study of the maple-sugar industry has resulted in the publication of a bulletin containing suggestions which are important to the farmers of the Northeastern United States. An exhaustive investigation has been conducted to determine the present available supply of Pacific coast tanbarks, and the best method of collecting the bark, while encouraging the reproduction of the trees on cut-over areas and providing for a more economical utilization of the timber.

A series of regional studies is furnishing a fuller knowledge of forest conditions and possibilities over large areas. This knowledge will enable the Bureau to answer an increased number of requests for assistance by sending the required information in printed form or by correspondence, instead of making a special examination on the ground in each case. Studies of the rate of growth, market conditions, and general characteristics of eight principal commercial trees of the Southern Appalachians, and of the available quantity and quality of timber which they furnish, have just been completed. Examinations of planted groves have been made in northern Illinois, in eastern Nebraska, and in the eastern part of the Dakotas and western Minnesota, and the data collected made available for future recommendations for forest planting in those regions. Investigations have also been conducted in California to determine the relation of chaparral to water supply and forest reproduction.

Tests of the mechanical and physical properties of various timbers were carried on at Berkeley, Cal., Lafayette, Ind., New Haven, Conn., St. Louis, Mo., and Washington, D. C. At these stations the strength of red fir, western hemlock, red gum, longleaf pine, and loblolly pine have been under investigation, sticks of the ordinary market grades being selected for the tests. Defects, such as knots, crooked grain, and checks, and the important facts with reference to the growth of the timber, are carefully noted. After the tests on the large pieces have been made, a small number of pieces are cut from the uninjured portions of the log and tested in the same manner. This enables a comparison to be made between the strength of the small clear pieces and the large sticks, and shows the weakening effect of unavoidable defects in the larger pieces. A series of tests is also being conducted to determine the mechanical properties of the various hardwoods which are now used or are probably available for use in the manufacture of vehicles. A study of the strength of second-growth red oak, for instance, has shown its high value as a substitute for white oak. Studies of various products, such as telephone cross-arms and pins, boxboards, etc., are in progress, and are expected to show how to economize material and to correct defects of practice.

FORESTRY PROVES HELPFUL TO THE RAILROADS.

Transportation companies are showing keen interest in the search for methods to prolong the life of ties and other timbers, which, if successful, will contribute to the conservation of forest resources. Several railroads are making extensive experiments with wooden tie-plates to lessen the wear of the tie under the rail. Two railroads of the Northwest have found it economical to carefully season their lodgepole pine ties, and are experimenting with seasoned western hemlock and red fir ties. Several western roads are using chemically preserved ties.

During the year 1904 the Bureau of Forestry established several new seasoning stations in different parts of the country, and investigations are now being conducted on twenty different kinds of wood. New methods of handling and treating timber have also been studied, and in several instances the large economies have led to the commercial use of the methods employed. Particular attention has been paid to determining the effect of treatment with various preservatives upon the strength of timber. One of the results is that the preliminary steaming usually practiced is found to reduce the strength of timber materially, and that water solutions, such as zinc chlorid and mercuric chlorid or corrosive sublimate, reduce the strength of timber to about the same extent as would an equal amount of water. Timber treated with such preservatives regains strength, however, upon drying out, whereas timber treated with creosote does not, because creosote remains in the wood in liquid form.

FOREST METHODS OF DISTINCT ADVANTAGE TO FARMERS.

Fence posts of cottonwood, ash, maple, and other perishable woods may be made to last 15, 20, and even 25 years by treating their butts with tar oil. This method of preservation has been investigated during the past year at St. Louis, and in cooperation with the Bureau of Forestry the farmers in the vicinity of Las Vegas, N. Mex., will treat a large number of posts for pasture fences in this way. Since fence posts are a necessity on every farm and ranch, this means of using timbers quickly grown but naturally subject to early decay will effect a great economy in regions where wood is scarce. The equipment has been simplified until the installation of a plant is a practicable undertaking for individuals or for a small community. The cost of materials does not exceed 5 to 7 cents for each post treated.

In the Eastern States particularly the farmers have shown interest in a more careful management of their woodlots. That this interest is rapidly spreading is evidenced by the fact that 80 applications for assistance were received from Ohio and 53 from Michigan. Over 40 woodlots were examined in Ohio during the past field season, and 25 in Michigan. (See Pl. LXXV, fig. 3.)

SYSTEMATIC METHODS IN FOREST PLANTING.

The assistance of the Bureau of Forestry has been extended as heretofore to many people desiring to establish permanent forest plantations. The service rendered becomes more and more effective as knowledge is acquired of the adaptability of various trees to the conditions of soil and climate in various localities, and of the most successful methods of propagating, transplanting, and cultivating trees.

Several States also have been encouraging forest extension by planting on their reservations. New York has established a plantation of deciduous trees at Cape Point, on the St. Lawrence River, and has prepared to set out several hundred thousand spruce seedlings the coming spring. During the past two years Pennsylvania has been planting white pine in open places on its reservations. In the Michigan forest reserve 40 acres of cut-over land were planted with 50,000 pines and spruces. Minnesota has raised a large number of young spruce trees with a view to planting 1,000 acres of reserve land if a State appropriation for this purpose can be secured.

On the Federal forest reserves tree planting is rapidly passing the experimental stage. On the Dismal River Forest Reserve, in Nebraska, the total cost of foresting sandhill country with pines (Pl. LXXV, fig. 2) has been reduced to $3.68 per acre. In southern California the work of reserve planting has been continued, and preliminary operations have been begun on the Pikes Peak Reserve in Colorado.

Various private interests likewise are turning to forest planting as a means of insuring a supply of wood to meet their necessities. A notable instance of this is offered by the Pennsylvania Railroad, which continues the planting of locust trees in Pennsylvania, 223,000 having been set out during the year. The chief engineer of maintenance of way estimates that it would require the planting of 1,300,000 trees each year to supply the annual needs of the road for ties, anticipating that the first crop will be harvested after thirty years. This example will stimulate the cultivation of tie timber by other landowners convenient to the railroads.

FOREST FIRES.

The number and destructiveness of forest fires during the past year were not so great as in 1903. Well-distributed rainfall accounts largely for this difference, but it is nevertheless conspicuous that nearly all the States which employ forest officers or maintain fire wardens escaped severe fires. Numerous fires started in those States, but they were extinguished before they gained great headway. It is to be noted that even throughout the regions of Montana, Idaho, Oregon, and Washington, where the greatest loss was suffered, the forest reserves and the few private holdings upon which fire patrol is attempted escaped with less injury than the totally unprotected forests adjoining. To establish a system of protection against or prevention of forest fires at a reasonable cost, it is necessary to know the causes of fires. Based upon the principle of closely watching the exposed points, effective work with economy of effort has been done the past summer in northern Maine, in the town of Plymouth in Massachusetts, in the region about South Mountain in Pennsylvania, and in the Sierras of California. The success attained by the Mount Pocono (Pennsylvania) Fire Protective Association emphasizes the advantage of thorough organization, and the importance of retaining patrolmen at a small salary to look out for fires throughout the year and of paying them promptly. In several States the prospects of effective control of the fires, upon which the future of American forestry so largely depends, is more promising than at any time in the past. (Pl. LXXV, fig. 4.)

FORESTRY AND FOREST LEGISLATION IN THE STATES.

New State forestry associations were formed in Iowa, Ohio, and Vermont. The activity in forest legislation shown by the States was apparently less in 1904 than in 1903, because only a few States held legislative sessions. Of these, Massachusetts passed a law providing for a technically trained State forester to care for the forest interests of the State. New York, heeding her disastrous lesson through forest fires in 1903, provided for a patrol to prevent future fire devastation. This law is a notable advance in two respects: It is a definite attempt to substitute preventive for remedial measures, and it requires railroads, the principal source of forest fire danger in the State reserves, to pay one-half the cost of a patrol along their lines. Louisiana passed a forest law providing for the care of wooded land in that State. There are now 11 States which have some form of forest administration, and the Bureau of Forestry has been called upon frequently to furnish advice with regard to proposed forest laws. This demand has been met by the publication of a bulletin containing a complete compilation of Federal and State forest laws, and by the preparation, in cooperation with State officials, of no less than 15 State forest bills to be submitted to the legislatures at their next sessions.

FOREST SCHOOLS.

The courses at the Yale Forest School, the Biltmore Forest School, the University of Michigan Forest School, and the Harvard University Forest School have been strengthened by the inclusion of new studies and the employment of additional instructors. Increased attendance gives evidence of prosperity at each institution.

EXHIBIT AT THE LOUISIANA PURCHASE EXPOSITION.

As a part of its educational work the Bureau of Forestry made an extensive exhibit at the Louisiana Purchase Exposition, St. Louis, Mo., of the forest conditions and problems found in all parts of the country and of the methods of Government work. Type forests and forest conditions of the East and the West, and scenes also of the treeless Middle West, were vividly portrayed by numerous large photographic transparencies and colored prints, uniquely arranged for comparison. The practical applications of forestry were features of this display. A wood-preserving plant and a timber-testing station were in practical operation. The new system of turpentining by cups and gutters, promoted by the Bureau, was contrasted with the old destructive method of boxing the trees, by means of a group of longleaf pine trunks. Out of doors a 3-acre tract of land was devoted to showing approved methods of raising forest trees from seed, and how forest plantations should be established in different parts of the country. The keenest interest was manifested in all these exhibits by the many visitors at the Exposition, and there is little doubt that the Bureau accomplished a good work by thus bringing forestry to the attention of so many people.

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CHARACTERISTIC SCENES IN ECONOMIC FORESTRY.

FIG. 1.—Seed trees left uninjured by logging and the burning of slash, Minnesota National Forest Reserve. FIG. 2.—Forest planting in the sandhills, Nebraska. FIG. 3.—The woodlot under forest management, South Dakota. FIG. 4.—A mountain trail which has stopped the progress of a fire, California. FIG. 5.—Application of the new system of cups and gutters in turpentining, Georgia.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 67.

Walter Mulford

FORESTRY FOR FARMERS.

BY

B. E. FERNOW,

Chief of the Division of Forestry.

[Reprinted from the Yearbooks of the U. S. Department of Agriculture for 1894 and 1895.]

WASHINGTON:
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1898.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF FORESTRY,
Washington, D. C., December 4, 1897.

SIR: I have the honor to recommend that the two articles contributed by me to the Yearbooks for 1894 and for 1895 on forestry for farmers be reprinted as a Farmers' Bulletin. The articles contain information in popular form regarding the growth of trees, the planting of a forest, treatment of the wood lot, the cultivation of the wood crop, influence of trees, etc. A wider distribution of this information, for which there is still considerable demand, would, I believe, result in acquainting farmers with a subject the importance of which has not always been duly recognized.

Very respectfully,

B. E. FERNOW, *Chief.*

Approved:
JAMES WILSON, *Secretary.*

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FORESTRY FOR FARMERS.

The following five chapters have been written with the view of aiding farmers who own small timber tracts or wood lots, or who wish to plant some part of their land to forest. This country varies so greatly in soil, climate, and flora that it is only possible, within the limits assigned for the present discussion, to outline general principles everywhere applicable. Nevertheless, wherever suggestions have approximated the laying down of rules of practice, the writer has had mainly in mind the conditions prevalent in our northeastern States. Moreover, for the reason already referred to, limitation of space, it has not been possible to give more than a comprehensive view, without much detail.

The succeeding chapters should be read connectedly, as they are more or less interdependent. The first treats of the behavior of a forest plant; the second, of the principles which should guide the planter in setting a crop; the third, of the manner in which a natural forest crop should be produced; the fourth points out how the crop should be managed afterwards in order to secure the best results in quantity and quality of material; while the fifth chapter is devoted to a consideration of the relation of forests to farms.

1. HOW TREES GROW.

Trees, like most other plants, originate from seed, build up a body of cell tissues, form foliage, flower, and fruit, and take up food material from the soil and air, which they convert into cellulose and other compounds, from which all their parts are formed. They rely, like other plants, upon moisture, heat, and light as the means of performing the functions of growth. Yet there are some peculiarities in their behavior, their life and growth, which require special attention on the part of a tree grower or forest planter, and these we shall briefly discuss.

FOOD MATERIALS AND CONDITIONS OF GROWTH.

Trees derive their food and solid substance in part from the air and in part from the soil. The solid part of their bodies is made up of cellulose, which consists largely of carbon (44 per cent of its weight), with hydrogen and oxygen added in almost the same proportions as in water. The carbon is derived from the carbonic acid of the air, which

enters into the leaves and, under the influence of light, air, and water, is there decomposed; the oxygen is exhaled; the carbon is retained and combined with elements derived from the water, forming compounds, such as starch, sugar, etc., which are used as food materials, passing down the tree through its outer layers to the very tips of the roots, making new wood all along the branches, trunk, and roots.

This process of food preparation, called "assimilation," can be carried on only in the green parts, and in these only when exposed to light and air; hence foliage, air, and light at the top are essential prerequisites for tree growth, and hence, other conditions being favorable, the more foliage and the better developed it is, and the more light this foliage has at its disposal for its work, the more vigorously will the tree grow.

In general, therefore, pruning, since it reduces the amount of foliage, reduces also, for the time, the amount of wood formed; and just so shading, reducing the activity of foliage, reduces the growth of wood.

SOIL CONDITIONS.

From the soil trees take mainly water, which enters through the roots and is carried through the younger part of the tree to the leaves, to be used in part on its passage for food and wood formation and in part to be given up to the air by transpiration.

In a vigorously growing tree the solid wood substance itself will contain half its weight in the form of water chemically combined, and the tree, in addition, will contain from 40 to 65 per cent and more of its dry weight in water mechanically or "hygroscopically" held. This last, when the tree is cut, very largely evaporates; yet well-seasoned wood still contains 10 to 12 per cent of such water. The weight of a green tree, a pine, for instance, is made up, in round numbers, of about 30 per cent of carbon and 70 per cent of water, either chemically or hygroscopically held, while a birch contains a still larger percentage of water.

The largest part of the water which passes through the tree is transpired—i. e., given off to the air in vapor. The amounts thus transpired during the season vary greatly with the species of tree, its age, the amount of foliage at work, the amount of light at its disposal, the climatic conditions (rain, temperature, winds, relative humidity), and the season. These amounts are, however, very large when compared with the quantity retained; so that while an acre of forest may store in its trees, say, 1,000 pounds of carbon, 15 to 20 pounds of mineral substances, and 5,000 pounds of water in a year, it will have transpired—taken up from the soil and returned to the air—from 500,000 to 1,500,000 pounds of water (one-quarter to one-half as much as agricultural crops).

Mineral substances are taken up only in very small quantities, and these are mostly the commoner sorts, such as lime, potash, magnesia, and nitrogen. These are carried in solution to the leaves, where they are used (as perhaps also on their passage through the tree), with a

part of the water, in food preparation. The main part of the mineral substances taken up remains, however, as the water transpires, in the leaves and young twigs, and is returned to the soil when the leaves are shed or when the tree is cut and the brush left to decompose and make humus.

Hence the improvement of the fertility of the soil by wood crops is explained, the minerals being returned in more soluble form to the soil; as also the fact that wood crops do not exhaust the soil of its minerals, provided the leaves and litter are allowed to remain on the ground.

For this reason there is no necessity of alternating wood crops, as far as their mineral needs are concerned; the same kind of trees can be grown on the same soil continuously, provided the soil is not allowed to deteriorate from other causes.

As the foliage can perform its work of food assimilation only when sufficient water is at its disposal, the amount of growth is also dependent not only on the presence of sufficient sources of supply, but also on the opportunity had by the roots to utilize the supply, and this opportunity is dependent upon the condition of the soil. If the soil is compact, so that the rain water can not penetrate readily, and runs off superficially, or if it is of coarse grain and so deep that the water rapidly sinks out of reach of the roots and can not be drawn up by capillary action, the water supply is of no avail to the plants; but if the soil is porous and moderately deep (depth being the distance from the surface to the impenetrable subsoil, rock, or ground water) the water not only can penetrate but also can readily be reached and taken up by the roots.

The moisture of the soil being the most important element in it for tree growth, the greatest attention must be given to its conservation and most advantageous distribution through the soil.

No trees grow to the best advantage in very dry or very wet soil, although some can live and almost thrive in such unfavorable situations. A moderately but evenly moist soil, porous and deep enough or fissured enough to be well drained, and yet of such a structure that the water supplies from the depths can readily be drawn up and become available to the roots—that is the soil on which all trees grow most thriftily.

The agriculturist procures this condition of the soil as far as possible by plowing, drainage, and irrigation, and he tries by cultivating to keep the soil from compacting again, as it does under the influence of the beating rain and of the drying out of the upper layers by sun and wind.

The forest grower can not rely upon such methods, because they are either too expensive or entirely impracticable. He may, indeed, plow for his first planting, and cultivate the young trees, but in a few years this last operation will become impossible and the effects of the first operation will be lost. He must, therefore, attain his object in another manner, namely, by shading and mulching the soil. The shading is

done at first by planting very closely, so that the ground may be protected as soon as possible from sun and wind, and by maintaining the shade well throughout the period of growth. This shade is maintained, if necessary, by more planting, and in case the main crop in later life thins out inordinately in the crowns or tops, or by the accidental death of trees, it may even become desirable to introduce an underbrush.

The mulching is done by allowing the fallen leaves and twigs to remain and decay, and form a cover of rich mold or humus. This protective cover permits the rain and snow waters to penetrate without at the same time compacting the soil, keeping it granular and in best condition for conducting water, and at the same time preventing evaporation at the surface.

The soil moisture, therefore, is best maintained by proper soil cover, which, however, is needful only in naturally dry soils. Wet soils, although supporting tree growth, do not, if constantly wet, produce satisfactory wood crops, the growth being very slow. Hence they must be drained and their water level sunk below the depth of the root system.

Irrigation is generally too expensive to be applied to wood crops, except perhaps in the arid regions, where the benefit of the shelter belt may warrant the expense.

Attention to favorable moisture conditions in the soil requires the selection of such kinds of trees as shade well for a long time, to plant closely, to protect the woody undergrowth (but not weeds), and to leave the litter on the ground as a mulch.

Different species, to be sure, adapt themselves to different degrees of soil moisture, and the crop should therefore be selected with reference to its adaptation to available moisture supplies.

While, as stated, all trees thrive best with a moderate and even supply of moisture, some can get along with very little, like the conifers, especially pines; others can exist even with an excessive supply, as the bald cypress, honey locust, some oaks, etc. The climate, however, must also be considered in this connection, for a tree species, although succeeding well enough on a dry soil in an atmosphere which does not require much transpiration, may not do so in a drier climate on the same soil.

In the selection of different kinds of trees for different soils, the water conditions of the soil should, therefore, determine the choice.

LIGHT CONDITIONS.

To insure the largest amount of growth, full enjoyment of sunlight is needed. But as light is almost always accompanied by heat and relative dryness of air, which demands water from the plant, and may increase transpiration from the leaves inordinately, making them pump too hard, as it were, young seedlings of tree species whose foliage is not built for such strains require partial shading for the first year or two. The conifers belong to this class.

In later life the light conditions exert a threefold influence on the development of the tree, namely, with reference to soil conditions, with reference to form development, and with reference to amount of growth.

The art of the forester consists in regulating the light conditions so as to secure the full benefit of the stimulating effect of light on growth, without its deteriorating influences on the soil and on form development.

As we have seen, shade is desirable in order to preserve soil moisture. Now, while young trees of all kinds, during the "brush" stage of development, have a rather dense foliage, as they grow older they vary in habit, especially when growing in the forest. Some, like the beech, the sugar maple, the hemlock, and the spruce, keep up a dense crown; others, like the chestnut, the oaks, the walnut, the tulip tree, and the white pine, thin out more and more, and when fully grown have a much less dense foliage; finally, there are some which do not keep up a dense shade for any length of time, like the black and honey locust, with their small, thin leaves; the catalpa, with its large but few leaves at the end of the branchlets only, and the larch, with its short, scattered bunches of needles. So we can establish a comparative scale of trees with reference to the amount of shade which they can give continuously, as densely foliaged and thinly foliaged, in various gradations. If we planted all beech or sugar maple, the desirable shading of the soil would never be lacking, while if we planted all locust or catalpa the sun would soon reach the soil and dry it out, or permit a growth of grass or weeds, which is worse, because these transpire still larger quantities of water than the bare ground evaporates or an undergrowth of woody plants would transpire. Of course, a densely foliaged tree has many more leaves to shed than a thinly foliaged one, and therefore makes more litter, which increases the favorable mulch cover of the soil. Another reason for keeping the ground well shaded is that the litter then decomposes slowly, but into a desirable humus, which acts favorably upon the soil, while if the litter is exposed to light, an undesirable, partly decomposed "raw" humus is apt to be formed.

Favorable soil conditions, then, require shade, while wood growth is increased by full enjoyment of light; to satisfy both requirements, mixed planting, with proper selection of shade-enduring and light-needing species, is resorted to.

As the different species afford shade in different degrees, so they require for their development different degrees of light. The dense foliage of the beech, with a large number of leaves in the interior of the crown, proves that the leaves can exist and perform their work with a small amount of light; the beech is a shade-enduring tree. The scanty foliage of the birches, poplars, or pines shows that these are light-needing trees; hence they are never found under the dense shade of the former, while the shade-enduring can develop satisfactorily

under the light shade of the thin-foliaged kinds. Very favorable soil conditions increase the shade endurance of the latter, and climatic conditions also modify their relative position in the scale.

All trees ultimately thrive best—i. e., grow most vigorously—in the full enjoyment of light, but their energy then goes into branching. Crowded together, with the side light cut off, the lower lateral branches soon die and fall, while the main energy of growth is put into the shaft and the height growth is stimulated. The denser shade of the shade-enduring kinds, if placed as neighbors to light-needing ones, is most effective in producing this result, provided that the light is not cut off at the top; and thus, in practice, advantage is taken of the relative requirements for light of the various species.[1]

The forester finds in close planting and in mixed growth a means of securing tall, clear trunks, free from knots, and he is able, moreover, by proper regulation of light conditions, to influence the form development, and also the quality of his crop, since slow growth and rapid growth produce wood of different character.

There are some species which, although light foliaged and giving comparatively little shade, are yet shade enduring—i. e., can subsist, although not develop favorably, under shade; the oaks are examples of this kind. Others, like the black cherry, bear a dense crown for the first twenty years, perhaps, seemingly indicating great shade endurance; but the fact that the species named soon clears itself of its branches and finally has a thin crown, indicates that it is light needing, though a good shader for the first period of its life. Others, again, like the catalpa, which is shady and shade enduring, as the difficulty with which it clears itself indicates, leaf out so late and lose their foliage so early that their shading value is thereby impaired. Black locust and honey locust, on the other hand, leave no doubt either as to their light-needing or their inferior shading quality.

That soil conditions and climatic conditions also modify crown development and shade endurance has been well recognized abroad, but in our country this influence is of much more importance on account of the great variation in those conditions. Thus the box elder, an excellent shader in certain portions of the West, is a failure as soil cover in others where it nevertheless will grow.

We see, then, that in determining the shading value as well as the shade endurance of one species in comparison with another, with reference to forestry purposes, not only soil and climate but also the character of foliage and its length of season must be considered.

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[1]This relation of the different species to varying light conditions, their comparative shading value and shade endurance, is one of the most important facts to be observed and utilized by the forester. European foresters have done this, but since they had to deal with only a few species and over a limited territory, they could quite readily classify their trees with reference to their shade endurance, and take it for granted that shade endurance and density of foliage or shading value were more or less identical. With our great wealth of useful species it will be necessary and profitable to be more exact in the classification.

As we have seen, root and foliage are the main life organs of the tree. The trunk and branches serve to carry the crown upward and expose it to the light, which is necessary in order to prepare the food and increase the volume of the tree, and also as conductors of food materials up and down between root and foliage. A large part of the roots, too, aside from giving stability to the tree, serve only as conductors of water and food material; only the youngest parts, the fibrous roots, beset with innumerable fine hairs, serve to take up the water and minerals from the soil. These fine roots, root hairs, and young parts are therefore the essential portion of the root system. A tree may have a fine, vigorous-looking root system, yet if the young parts and fibrous roots are cut off or allowed to dry out, which they readily do—some kinds more so than others—thereby losing their power to take up water, such a tree is apt to die. Under very favorable moisture and temperature conditions, however, the old roots may throw out new sprouts and replace the fibrous roots. Some species, like the willows, poplars, locusts, and others, are especially capable of doing so. All trees that "transplant easily" probably possess this capacity of renewing the fibrous roots readily, or else are less subject to drying out. But it may be stated as a probable fact that most transplanted trees which die soon after the planting do so because the fibrous roots have been curtailed too much in taking up, or else have been allowed to dry out on the way from the nursery or forest to the place of planting; they were really dead before being set. Conifers—pines, spruces, etc.—are especially sensitive; maples, oaks, catalpas, and apples will, in this respect, stand a good deal of abuse.

Hence, in transplanting, the first and foremost care of the forest grower, besides taking the sapling up with least injury, is the proper protection of its root fibers against drying out.

The water, with the minerals in solution, is taken up by the roots when the soil is warm enough, but to enable the roots to act they must be closely packed with the soil. It is conveyed mostly through the outer, which are the younger, layers of the wood of root, trunk, and branches to the leaves. Here, as we have seen, under the influence of light and heat it is in large part transpired and in part combined with the carbon into organic compounds, sugar, etc., which serve as food materials. These travel from the leaf into the branchlet, and down through the outer layers of the trunk to the very tips of the root, forming new wood all the way, new buds, which lengthen into shoots, leaves, and flowers, and also new rootlets. To live and grow, therefore, the roots need the food elaborated in the leaves, just as the leaves need the water sent up from the roots.

Hence the interdependence of root system and crown, which must be kept in proportion when transplanting. At least, the root system must be sufficient to supply the needs of the crown.

"SAP UP AND SAP DOWN."

The growing tree, in all its parts, is more or less saturated with water, and as the leaves, under the influence of sun and wind and atmospheric conditions generally transpire, new supplies are taken in through the roots and conveyed to the crown. This movement takes place even in winter, in a slight degree, to supply the loss of water by evaporation from the branches. In the growing season it is so active as to become noticeable; hence the saying that the sap is "up," or "rising," and when, toward the end of the season, the movement becomes less, the sap is said to be "down." But this movement of water is always upward; hence the notion that there is a stream upward at one season and in one part of the tree, and a stream downward at another season and perhaps in another part of the tree, is erroneous. The downward movement is of food materials, and the two movements of water upward and food downward take place simultaneously, and depend, in part at least, one upon the other, the food being carried to the young parts, wherever required, by a process of diffusion from cell to cell known as "osmosis."

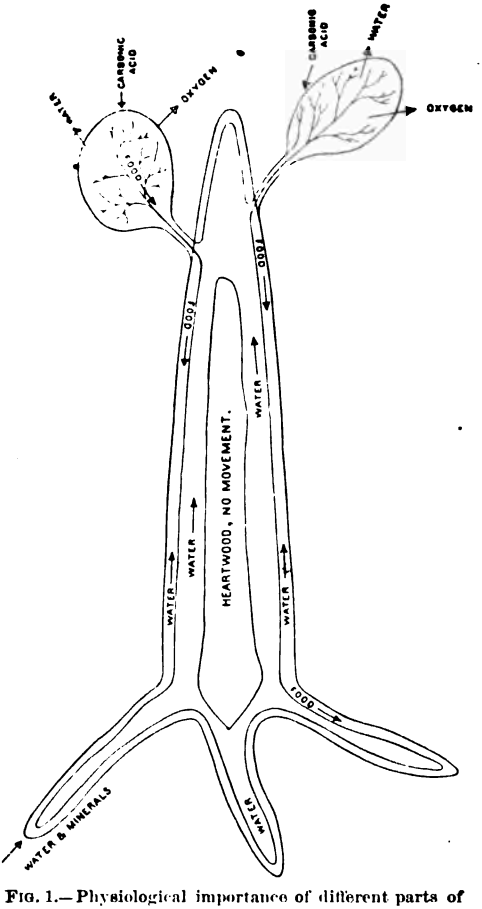

FIG. 1.—Physiological importance of different parts of the tree; pathways of water and food materials. (Schematic.)

These food materials are, by the life processes of the active cells, changed in chemical composition as need be, from sugar, which is soluble, into starch, which is insoluble, and back into sugar, and combined with nitrogenous substances to make the cell-forming material, protoplasm (fig. 1).

In the fall, when the leaves cease to elaborate food, both the upward and the downward movement, more or less simultaneously, come to rest (the surplus of food materials, as starch, and sometimes as sugar, being stored for the winter in certain cell tissues), to begin again simultaneously when in spring the temperature is high enough to reawaken

activity, when the stored food of last year is dissolved and started on its voyage. The exact manner in which this movement of water upward and food materials downward takes place, and the forces at work, are not yet fully understood, nor is there absolute certainty as to the parts of the tree in which the movement takes place. It appears, however, that while all the so-called "sapwood" is capable of conducting water (the heartwood is probably not), the most active movement of both water and food materials takes place in the cambium (the growing cells immediately beneath the bark) and youngest parts of the bark.

The deductions from these processes important to the planter are: That injury to the living bark or bast means injury to growth, if not destruction to life; that during the period of vegetation transplanting can be done only with great caution; that the best time to move trees is in the fall, when the leaves have dropped and the movement of water and food materials has mostly ceased, or in spring, before the movement begins again, the winter being objectionable only because of the difficulty of working the soil and of keeping the roots protected against frost. All things considered, spring planting, before activity in the tree has begun, is the best, although it is not impossible to plant at other times.

PROGRESS OF DEVELOPMENT.

Like the wheat or corn plant, the tree seed require as conditions for sprouting sufficient moisture, warmth, and air. Tree seeds, however, differ from grain in that most of the kinds lose their power of germination easily; with few exceptions (locust, pine, spruce), they can not be kept for any length of time.

The first leaves formed often differ essentially in shape from those of the mature tree, which may cause their being confounded with other plants, weeds, etc.

The little seedlings of many, especially the conifers, are quite delicate, and remain very small the first season; they need, therefore, the protecting shade of mother trees, or artificial shading, and also protection against weeds. The amount of light or shade given requires careful regulation for some of them; too much light and heat will kill them, and so will too much shade. This accounts for the failure of many seedlings that spring up in the virgin forest.

The planter, then, is required to know the nature and the needs of the various kinds of seeds and seedlings, so as to provide favorable conditions, when he will avoid sowing in the open field such as require the care which it is impracticable to give outside of the nursery.

GROWTH IN LENGTH AND RAMIFICATION.

While the stalk of wheat or corn grows for one season, exhausts itself in seed production, and then dies, the tree continues to grow from season to season, in length as well as in thickness. The growth

in length of shaft and branches proceeds from buds, made up of cell tissues, which can subdivide and lengthen into shoots, as well as make leaves. These buds are formed during summer, and when winter begins contain embryo leaves, more or less developed, under the protecting cover of scales (fig. 3). When spring stimulates the young plant to new activity, the buds swell, shed their scales, dis-

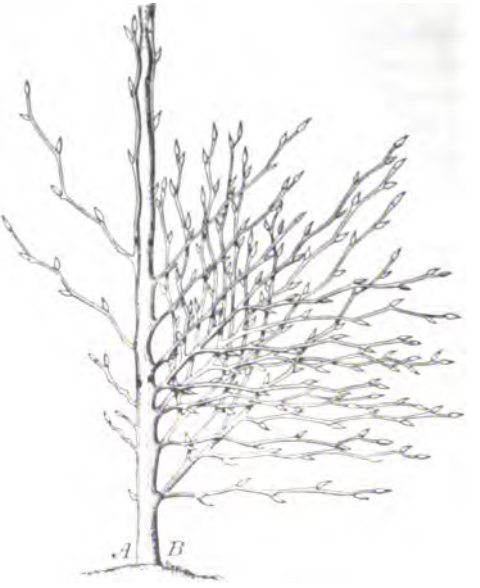

FIG. 2.—Bud development of beech. *B*, as it would be if all formed buds were to live; *A*, as it is, many buds failing to develop.

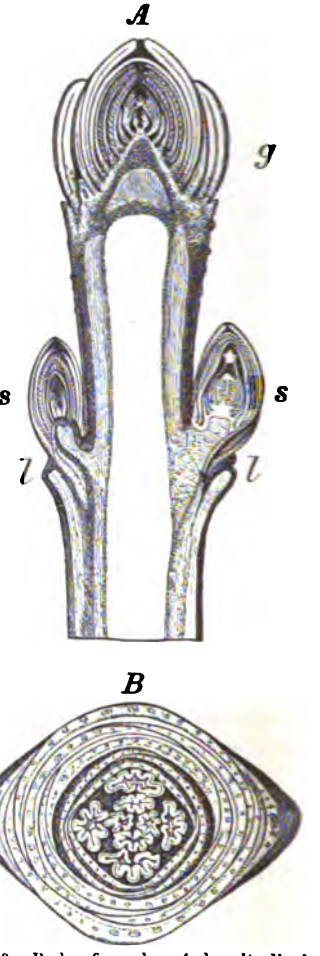

FIG. 3.—Buds of maple. *A*, longitudinal section through tip of a maple twig; *g*, end bud; *s*, lateral buds; *l*, scars of leaves of last season. *B*, cross section through end bud, showing folded leaves in center and scales surrounding them.

tend their cells, increasing their number by subdivision, and thus the leaves expand, and the bud lengthens into a shoot and twig. During the season new buds are formed, and the whole process repeats itself from year to year, giving rise to the ramification and height growth of the tree. The end buds being mostly stronger and better developed, the main axis of tree or branch increases more rapidly than the rest. All these buds originate from the youngest, central part of the shoot, the pith, and hence when the tree grows in thickness, enveloping the base of the limbs, their connection with the pith can always be traced. This is the usual manner of bud formation; in addition, so-called "adventitious" buds may be formed from the young living wood in later life, which are not connected with the pith. Such buds are those which develop into sprouts from the stump when the tree is

cut; also those which give rise to what are known as "water sprouts." Many buds, although formed, are, however, not developed at once, and perhaps not at all, especially as the tree grows older; these either die or remain "dormant," often for a hundred years, to spring into life when necessary (fig. 4).

The fact that each ordinary limb starts as a bud from the pith is an important one to the timber grower; it explains knotty timber and gives him the hint that in order to obtain clear timber the branches

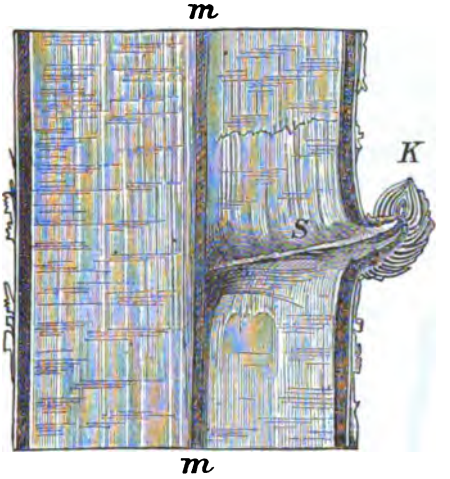

FIG. 4.—Dormant bud, *K*, on a 12-year old branch of beech. The bud is still capable of development and is connected with the pith, *mm*, of the stem by a fine trace of pith, *S*.

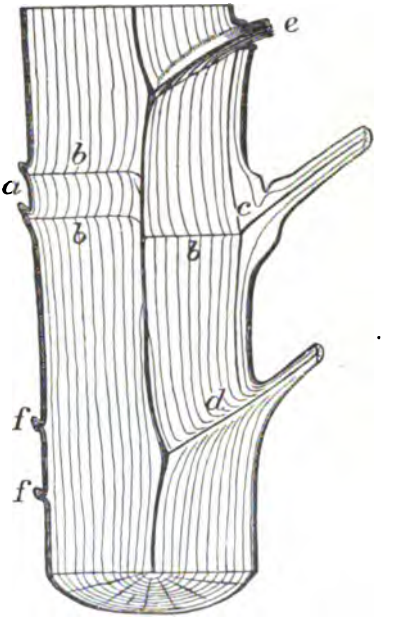

FIG. 5.—Section through a 12-year old stem of beech, showing manner of bud and limb formation. *a*, dormant buds; *b*, their trace of pith extending to the pith of the stem; *c*, a limb which started two years ago from a dormant bud; *d*, normal limb; *e*, a limb dead for four years; *f*, adventitious buds.

first formed must be soon removed, either by the knife or by proper shading, which kills the branches and thus "clears" the shaft.

The planter has it also in his power to influence the form development of the tree by removing some of the buds, giving thereby better chance to the remaining ones. This pruning of buds is, where practicable, often better practice than the pruning of limbs.

Since the tree does not grow in length except by its buds it is evident that a limb which started to grow at the height of 6 feet has its base always 6 feet from the ground, and if allowed to grow to size, must be surrounded by the wood which accumulates on the main stem or trunk. If a limb is killed and broken off early, only a slender stub composed entirely of rapidly decaying sapwood, is left, occasioning, therefore, only a small defect in the heart of the tree; but if left to grow to considerable age, the base of the limb is incased by the wood of the stem, which, when the tree is cut into lumber, appears as a knot.

The longer the limb has been allowed to grow, the farther out is the timber knotty and the thicker is the knot. If the limb remained alive, the knot is "sound," closely grown together with the fibers of the tree. If the limb died off, the remaining stub may behave in different ways. In pines it will be largely composed of heartwood, very resinous and durable; separated from the fibers of the overgrowing wood, it forms a "loose" knot, which is apt to fall out of a board, leaving a hole.

In broad-leaved trees, where no resin assists in the process of healing, the stub is apt to decay, and this decay, caused by the growth of fungi, is apt to penetrate into the tree (fig. 6). In parks and orchards, pruning is resorted to, and the cuts are painted or tarred to avoid the decay. In well-managed forests and dense woods in general, the light is cut off, the limb is killed when young and breaks away, the shaft "clears itself," and the sound trunk furnishes a good grade of material. The difference in development of the branch system, whether in full enjoyment of light, in open stand, or with the side light cut off, in dense position, is shown in the accompanying illustration (fig. 7).

FIG. 6.—Section through a partly decayed knot in oak wood. *a*, wood of the knot; *b* and *c*, wood callus of the stem covering the wound; shaded portion, decayed wood; black part, a cavity remaining.

Both trees start alike; the one retains its branches, the other loses them gradually, the stubs being in time overgrown; finally the second has a clear shaft, with a crown concentrated at the top, while the first is beset with branches and branch stubs for its whole length (fig. 8).

When ripped open lengthwise, the interior exhibits the condition shown in figure 9, the dead parts of the knot being indicated in heavier shading. Since the branches grow in more or less regular whorls, several knots, stumps, or limbs are met every 6 to 24 inches through the entire stem.

Hence, in forest planting, trees are placed and kept for some time close together, in order to decrease the branching in the lower part of the tree and thus produce a clean bole and clear lumber.

GROWTH IN THICKNESS.

The young seedling and the young shoot of the older tree much resemble in interior structure that of any herbaceous plant, being composed of a large amount of pith, loose squarish cells, and a few bundles of long fibers symmetrically distributed about the center, the whole covered with a thin skin or epidermis. Each strand or bundle of

fibers, called fibro-vascular (fiber-vessel) bundles, consists of two kinds, namely, wood fibers on the inner side and bast fibers of different structure on the outer side. Between these two sets of fibers, the bast and the wood, there is a row of cells which form the really active, growing part of the plantlet, the cambium. The cambium cells are actively subdividing and expanding, giving off wood cells to the interior and bast cells to the exterior, and extending at the same time sidewise, until at the end of the season not only are the wood and bast portions increased in lines radiating from the center, but the cambium layer, the wood cells, and the bast cells of all the bundles (scattered at the beginning) join at the sides to form a complete ring, or rather hollow cylinder, around the central pith. Only here and there the pith cells remain, interrupting the wood cylinder and giving rise to the system of cells known as medullary rays. The cross section now shows a comparatively small amount of pith and bast or bark and a larger body of strong wood fibers. The new shoot at the end, to be sure, has the same appearance and arrangement as the young plantlet had, the pith preponderating, and the continuous cylinder of cambium, bast, and wood being separated into strands or bundles.

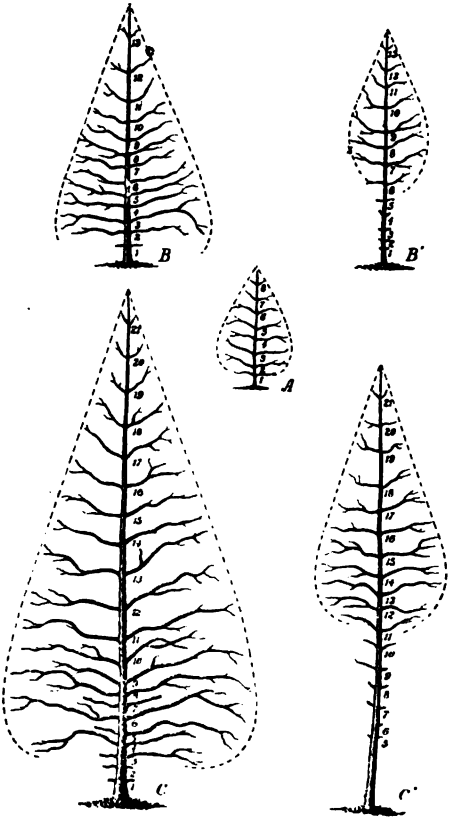

FIG. 7.—Development in and out of the forest. *A*, young tree alike in both cases; *B* and *C*, successive stages of tree grown in the open; *B'* and *C'*, corresponding stages of the tree grown in the forest. Numbers refer to annual growth in height.

During the season, through the activity of the cambial part of the bundles, the same changes take place in the new shoot as did the previous year in the young seedling, while at the same time the cambium in the yearling part also actively subdivides, forming new wood and bast cells, and thus a second ring, or rather cylinder, is formed. The cambium of the young shoot is always a continuation of that of the ring or cylinder formed the year before, and this cambium cylinder always keeps moving outward, so that at the end of the season, when activity ceases, it is always the last minute layer of cells on the outside of the wood, between wood proper and

bark. It is here, therefore, that the life of the tree lies, and any injury to the cambium must interfere with the growth and life of the tree.

The first wood cells which the cambium forms in the spring are usually or always of a more open structure, thin walled, and with a large opening or "lumen," comparable to a blown-up paper bag; so large, in fact, sometimes, is the "lumen" that the width of the cells can be seen on a cross section with the naked eye, as, for instance, in oak, ash, elm, the so-called "pores" are this open wood formed in spring. The cells, which are formed later in summer, have mostly thick walls, are closely crowded and compressed, and show a very small opening or "lumen," being comparable, perhaps, to a very thick wooden box. They appear in the cross section not only denser but of a deeper color, on account of their crowded, compressed condition and thicker walls. Since at the beginning of the next season again thin-walled cells with wide openings or lumina are formed, this difference in the appearance of "spring wood" and "summer wood" enables us to distinguish the layer of wood formed each year. This "annual ring" is more conspicuous in some kinds than in others.

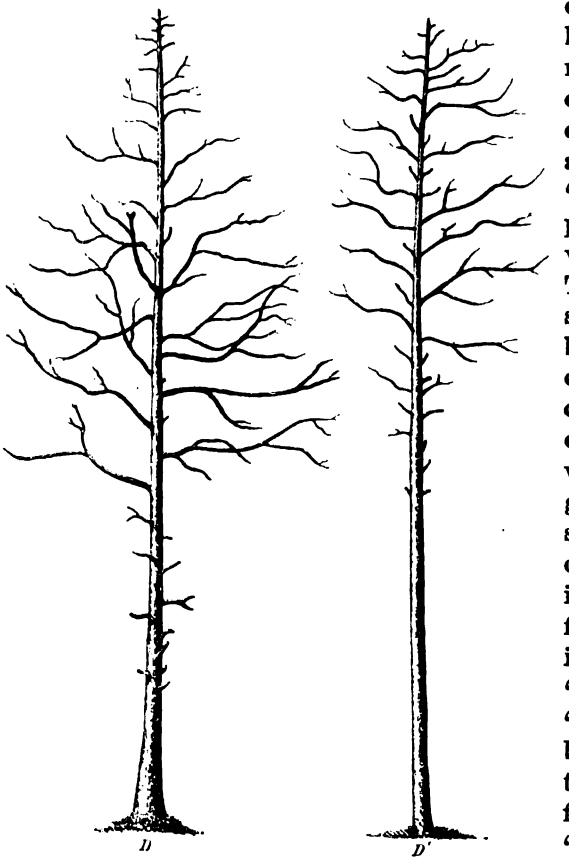

FIG. 8.—Trees in and out of the forest. *D*, tree grown in the open; *D'*, tree grown in the forest.

In the so-called "ring porous" woods, like oak, ash, elm, the rings are easily distinguished by the open spring wood; in the conifers, especially pines, by the dark-colored summer wood; while in maple, birch, tulip, etc., only a thin line of flattened, hence darker and regularly aligned, summer cells, often hardly recognizable, distinguishes the rings from each other. Cutting through a tree, therefore, we can not only ascertain its age by counting its annual layers in the cross section, but also determine how much wood is formed each year (fig. 10). We

can, in fact, retrace the history of its growth, the vicissitudes through which it has passed, by the record preserved in its ring growth.

To ascertain the age of a tree correctly, however, we must cut so near to the ground as to include the growth of the first year's little plantlet; any section higher up shows as many years too few as it took the tree to reach that height.

This annual-ring formation is the rule in all countries which have distinct seasons of summer and winter and temporary cessation of growth. Only exceptionally a tree may fail to make its growth throughout its whole length on account of loss of foliage or other causes; and occasionally, when its growth has been disturbed during the season, a "secondary" ring, resembling the annual ring, and distinguishable only by the expert, may appear and mar the record.

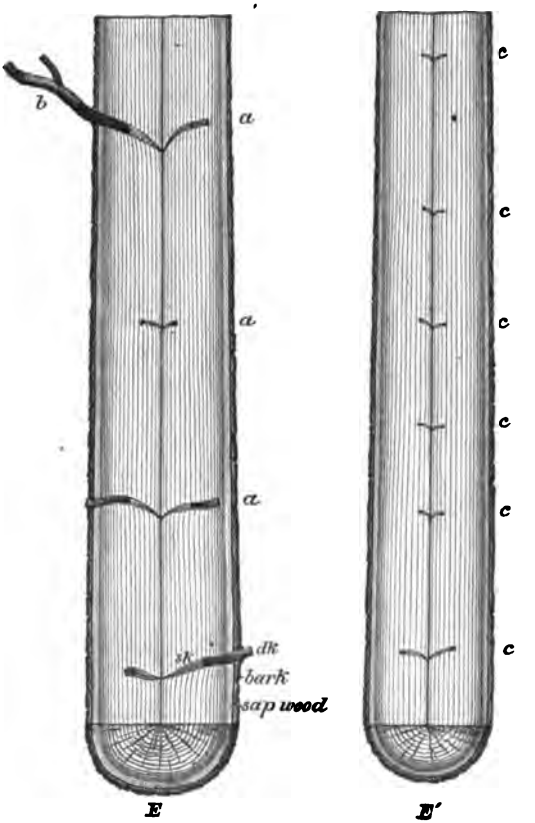

FIG. 9.—Sections of logs showing the relative development of knots. *E*, from tree grown in the open; *E'*, from tree grown in a dense forest; *a* and *c*, whorls of knots; *b*, dead limb; *sk*, "sound knot;" *dk*, "dead knot."

To the forest planter this chapter on ring growth is of great importance, because not only does this feature of tree life afford the means of watching the progress of his crop, calculating the amount of wood formed, and therefrom determining when it is most profitable for him to harvest (namely, when the annual or periodic wood growth falls below a certain amount), but since the proportion of summer wood and spring wood determines largely the quality of the timber, and since he has it in his power to influence the preponderance of the one or other by adaptation of species to soils and by their management, ring growth furnishes an index for regulating the quality of his crop.

FORM DEVELOPMENT.

If a tree is allowed to grow in the open, it has a tendency to branch, and makes a low and spreading crown. In order to lengthen its shaft and to reduce the number of branches it is necessary to narrow its

growing space, to shade its sides so that the lower branches and their foliage do not receive light enough to perform their functions. When the side shade is dense enough, these branches die and finally break off under the influence of winds and fungous growth; wood then forms over the scars and we get a clean shaft which carries a crown high up beyond the reach of shade from neighbors.

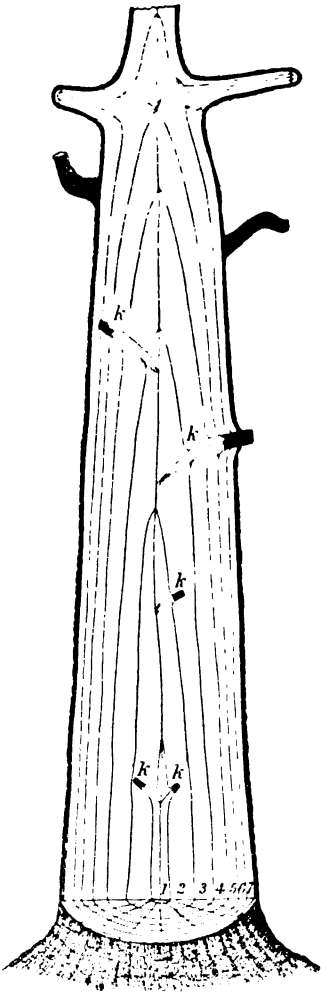

FIG. 10.—Scheme to illustrate the arrangement of annual growth. 1, 2, 3, etc., represent the parts of the stem grown during the first, second, third, etc., twenty years of the life of the tree. *k*, knots; the shaded part of each is the "dead knot" of lumber.

The branches being prevented from spreading out, the shaft is forced to grow upward, and hence, when crowded by others, trees become taller and more cylindrical in form, while in the open, where they can spread, they remain lower and more conical in form (figs. 11,12).

There are, to be sure, different natural types of development, some, like the walnuts, oaks, beeches, and the broad-leafed trees generally, having greater tendency to spread than others, like spruces, firs, and conifers in general, which lengthen their shaft in preference to spreading, even in the open. This tendency to spreading is also influenced by soil conditions and climate, as well as by the age of the tree. When the trees cease to grow in height, their crowns broaden, and this takes place sooner in shallow soils than in deep, moist ones; but the tendency can be checked and all can be made to develop the shaft at the expense of the branches by proper shading from the sides.

It follows that the forest planter, who desires to produce long and clean shafts and best working quality of timber, must secure and maintain side shade by a close stand, while the landscape gardener, who desires characteristic form, must maintain an open stand and full enjoyment of light for his trees.

Now, as we have seen, different species afford different amounts of shade, and in proportion to the shade which they afford can they endure shade. The beech or sugar maple or spruce, which maintain a large amount of foliage under the dense shade of their own crown, show that their leaves can live and functionate with a small amount of light. They are shade-enduring trees. On the other hand,

the black walnut, the locust, the catalpa, the poplars, and the larch show by the manner in which their crowns thin out, the foliage being confined to the ends of the branches, that their leaves require more light—they are light-needing trees; so that the scale which arranges the trees according to the amount of shade they exert serves also to measure their shade endurance.

In making, therefore, mixed plantations, the different kinds must be so grouped and managed that the shady trees will not outgrow and overtop the light-needing; the latter must either have the start of the former or must be quicker growers.

RATE OF GROWTH.

Not only do different species grow more or less rapidly in height and girth, but there is in each species a difference in the rate of growth during different periods of life, and a difference in the persistence of growth.

It stands to reason that trees grow differently in different soils and situations, and hence we can not compare different species with respect to their rate of growth except as they grow under the same conditions.

FIG. 11.—Oak tree grown in the open.

FIG. 12.—Maple tree grown in the forest.

Thus the black walnut may grow as fast as or faster than the ash on a rich, deep, moist, warm soil, but will soon fall to the rear in a wetter, colder, and shallower soil.

Given the same conditions, some species will start on a rapid upward growth at once, like the poplars, aspen, locust, and silver maple, making rapid progress (the most rapid from their tenth to their fifteenth year), but decreasing soon in rate and reaching their maximum height early. Others, like the spruce, beech, and sugar maple, will begin slowly, often occupying several, sometimes as many as 10 to 15, years before they appear to grow at all, their energy all going into root growth. Then comes a period of more and more accelerated growth, which reaches its maximum rate at 25 or 30 years; and when the cottonwood or aspen

has reached the end of its growth in height the spruce or pine is still at its best rate, and continues to grow for a long time at that rate; in later life the rate decreases, yet height growth sometimes does not cease altogether for centuries. As a rule, the light-needing species are the ones which show the rapid height growth at the start, while the shade-enduring are slow at the start, but persistent growers.

This fact is important in explaining the alternations of forest growth in nature; the persistent shade-enduring species crowd out the light-needing, and the latter rapidly take possession of any openings that fire or storm has made. It is also important with reference to the management of wood crops and starting of mixed plantations; the light-needing species must be mixed only with such shade-enduring species as are slower growers than themselves.

The diameter growth shows also periodic changes in its rate, and is, of course, influenced in the same way by soil, climate, and light conditions, as the height growth.

In the juvenile or brush stage, lasting 6 to 10 years in light-needing and 20 to 40 years in shade-enduring species, the diameter grows comparatively little, all energy being directed to height growth and root growth. When the crown has been definitely formed, more food material is available for wood formation, and the increase in foliage is accompanied by a more rapid increase of trunk diameter; in favorable situations, the highest rate occurs between the fortieth and sixtieth years; in the poorer situations, between the fiftieth and eightieth years, which rate continues for some time. Then comes a period of slower rate, which finally in old age dwindles down almost to zero.

But neither the diameter growth nor the width of the annual rings alone tells us directly what amount of wood is forming. The outer rings, being laid over a larger circumference, although thinner than the preceding rings, may yet have greater cubic contents. The statements of diameter growth are, therefore, misleading if we are interested in knowing how much wood is forming.

Accordingly the growth in volume must be considered separately, as determined by the enlargement of the cross-section area and the height. The growth in volume or mass accretion is quite small in young trees, so that when wood is cut young the smallest amount of crop per year is harvested, while, if it is allowed to grow, an increase more than proportionate to the number of years may be obtained.

Only when the tree has a fully developed crown does it begin to make much wood. Its volume growth progresses then at a uniform rate, and continues to do so for decades, and sometimes for a century or more.

On poorer sites the rate is slower, but remains longer on the increase, while on good sites the maximum rate is soon reached.

Of course, in a forest, where light conditions are not most favorable, because form development and soil conditions require shade, the total wood formation is less than in an isolated tree, favorably placed. Just

so the dominant trees in a forest—i. e., those which have their crowns above all others—show, of course, the advantage they have over the inferior trees which are suffering from the shade of their neighbors.

Finally, if we would take into consideration an entire forest growth, and determine, for instance, how much wood an acre of such forest produces at different periods, we must not overlook the fact that the number of trees per acre changes as the trees grow older. Some of them are overshaded and crowded out by the others, so that a young growth of spruce might start with 100,000 little seedlings to the acre, of which in the twentieth year only 10,000 would be alive, while in the fortieth year the number would be reduced to 1,200, and in the hundredth year to 280. Hence the rate of growth of any single tree gives no idea of what the acre of forest will do.

Thus, while a single good white pine might grow the fastest in volume when about one hundred years old, then making wood at the rate of, say, 1.5 cubic feet per year, an acre of pine on good soil, containing about 1,600 trees, may make the most wood in the thirtieth year, then growing at the rate of 170 cubic feet per acre, while in the hundredth year the rate would not exceed 70 cubic feet; and an acre of pine in a poorer location, with about 1,400 trees, may make the most wood in the fortieth year, at the rate of 100 cubic feet per acre.

From the consideration of the relation of light conditions to soil conditions, to form development, and to rate of growth, we may make the following deductions of interest to the forest planter:

In order to secure the best results in wood production, in quantity and quality, at the same time preserving favorable soil conditions, the forest should be composed of various species, a mixture of light-needing and shade-enduring kinds. The light-needing ones should be of quicker growth; the shady ones, in larger numbers, should be slower growers. For the first fifteen to twenty-five years the plantation should be kept as dense as possible, to secure clear shafts and good growth in height; then it should be thinned, to increase crown development and diameter growth; the thinning, however, is not to be so severe that the crowns can not close up again in two or three years; the thinning is to be repeated again and again, always favoring the best developed trees.

REPRODUCTION.

All trees reproduce themselves naturally from seed. Man can secure their reproduction also from cuttings or layers; and some kinds can reproduce themselves by shoots from the stump when the parent tree has been cut. This latter capacity is possessed in a varying degree by different species; chestnuts, oaks, elms, maples, poplars, and willows are most excellent sprouters; most conifers do not sprout at all, and the shoots of those that do sprout soon die (Sequoia or California redwood seems to be an exception). Sprouts of broad-leafed trees develop differently from seedlings, growing very rapidly at first, but soon lessening in the rate of growth and never attaining the height and perhaps not

the diameter of trees grown from the seed; they are also shorter lived. With age the stumps lose their capacity for sprouting. To secure best results, the parent tree should be cut close to the ground in early spring, avoiding severe frost, and a sharp cut should be made which will not sever the bark from the trunk.

Not all trees bear seed every year, and plentiful seed production, especially in a forest, occurs, as a rule, periodically. The periods differ with species, climate, and season.

Not all seeds can germinate, and in some species the number of seeds that can germinate is very small, and they lose their power of germination when kept a few hours, like the willows. Others, if kept till they have become dry, will "lie over" in the soil a year or more before germinating. The same thing will occur if they are covered too deep in the soil, provided they germinate at all under such conditions.

In order to germinate, seeds must have warmth, air, and moisture. The preparation of a seed bed is, therefore, necessary in order to supply these conditions in most favorable combination. In the natural forest millions of seeds rot or dry without sprouting, and millions of seedlings sprout, but soon perish under the too dense shade of the mother trees.

Man, desiring to reproduce a valuable wood crop, can not afford to be as lavish as nature, and must therefore improve upon nature's methods, making more careful preparation for the production of his crop, either by growing the seedlings in nurseries and transplanting them, or else by cutting away the old growth in such a manner as to secure to the young self-grown crop better chances for life and development.

2. HOW TO PLANT A FOREST.

Forest planting and tree planting are two different things. The orchardist, who plants for fruit; the landscape gardener, who plants for form; the roadside planter, who plants for shade, all have objects in view different from that of the forest planter, and therefore select and use their plant material differently. They deal with single individual trees, each one by itself destined for a definite purpose. The forester, on the other hand, plants a crop like the farmer; he deals not with the single seed or plant, but with masses of trees; the individual tree has value to him only as a part of the whole. It may come to harvest for its timber, or it may not come to harvest, and yet have answered its purpose as a part of the whole in shading the ground, or acting as nurse or "forwarder" as long as it was necessary.

His object is not to grow trees, but to produce wood, the largest amount of the best quality per acre, whether it be stored in one tree or in many, and his methods must be directed to that end.

As far as the manner of setting out plants or sowing seeds is concerned, the same general principles and the same care in manipulation are applicable as in any other planting, except as the cost of operating

on so large a scale may necessitate less careful methods than the gardener or nurseryman can afford to apply; the nearer, however, the performance of planting can be brought to the careful manner of the gardener, the surer the success. The principles underlying such methods have been discussed in the chapter "How trees grow;" in the present chapter it is proposed to point out briefly the special considerations which should guide the forest planter in particular.

WHAT TREES TO PLANT.

Adaptability to climate is the first requisite in the species to be planted.

It is best to choose from the native growth of the region which is known to be adapted to it. With regard to species not native, the reliance must be placed upon the experience of neighboring planters and upon experiment (at first on a small scale), after study of the requirements of the kinds proposed for trial.

Adaptation must be studied, not only with reference to temperature ranges and rainfall, but especially with reference to atmospheric humidity and requirements of transpiration.

Many species have a wide range of natural distribution, and hence of climatic adaptation. If such are to be used, it is important to secure seeds from that part of the range of natural distribution where the plants must be hardiest, i. e., the coldest and driest region in which it occurs, which insures hardy qualities in the offspring. For instance, the Douglas spruce from the humid and evenly tempered Pacific Slope will not be as hardy as that grown from seed collected on the dry and frigid slopes of the Rockies. Lack of attention to this requisite accounts for many failures. It must also be kept in mind that, while a species may be able to grow in another than its native climate, its wood may not there have the same valuable qualities which it develops in its native habitat.

Adaptability to soil must be studied less with reference to mineral constituents than to physical condition. Depth and moisture conditions, and the structure of the soil, which influences the movement of water in it, are the most important elements. While all trees thrive best in a moist to "fresh" soil of moderate depth (from 2 to 4 feet) and granular structure, some can adapt themselves to drier or wetter, shallow, and compact soils. Fissures in rocks into which the roots can penetrate often stand for depth of soil, and usually aid in maintaining favorable moisture conditions. In soils of great depth (i. e., from the surface to the impenetrable subsoil) and of coarse structure water may drain away so fast as not to be available to the roots.

Soil moisture must always be studied in conjunction with atmospheric moisture; for, while a species may thrive in an arid soil, when the demands of transpiration are not great, it may not do so when aridity

of atmosphere is added. Trees of the swamp are apt to be indifferent to soil moisture and to thrive quite well, if not better, in drier soils.

Adaptability to site.—While a species may be well adapted to the general climatic conditions of a region, and in general to the soil, there still remains to be considered its adaptability to the particular "site," under which term we may comprise the total effect of general climate, local climate, and soil. The general climatic conditions are locally influenced, especially by the slope, exposure, or aspect, and the surroundings. Thus we know that eastern exposures are more liable to frost, western exposures more liable to damage from winds, southern more apt to be hot and to dry out, and northern to be cooler and damper, having in consequence a shorter period of vegetation. Hollows and lowlands are more exposed to frosts and more subject to variations in soil moisture, etc.

Hence for these various situations it is advisable to select species which can best withstand such local dangers.

The use value, or utility, of the species is next to be considered. This must be done with reference to the commercial and domestic demand, and the length of time it takes the species to attain its value. The greater variety of purposes a wood may serve—i. e., the greater its general utility—and the sooner it attains its use value the better. White pine for the northeastern States as a wood is like the apple among fruits, making an all-round useful material in large quantities per acre in short time. Tulip poplar, applicable to a wider climatic range, is almost as valuable, while oak, ash, and hickory are standard woods in the market. Other woods are of limited application. Thus the black locust, which grows most quickly into useful posts, has only a limited market, much more limited than it should have; hickory soon furnishes valuable hoop poles from the thinnings, and later the best wagon material, not, however, large quantities in a short time; while black walnut of good quality is very high in price, the market is also limited, and the dark color of the heartwood, for which it is prized, is attained only by old trees. The black cherry, used for similar purposes, attains its value much sooner.

By planting various species together, variety of usefulness may be secured and the certainty of a market increased.

The forest value of the species is only in part expressed by its use value. As has been shown in another place, the composition of the crop must be such as to insure maintenance of favorable soil conditions, as well as satisfactory development of the crop itself. Some species, although of high use value, like ash, oak, etc., are poor preservers of soil conditions, allowing grass and weeds to enter the plantation and to deteriorate the soil under their thin foliage. Others, like beech, sugar maple, box elder, etc., although of less use value, being dense foliaged and preserving a shady crown for a long time, are of great forest value as soil improvers.

Again, as the value of logs depends largely on their freedom from knots, straightness, and length, it is of importance to secure these qualities. Some valuable species, if grown by themselves, make crooked trunks, do not clean their shafts of branches, and are apt to spread rather than lengthen. If planted in close companionship with others, they are forced by these "nurses or forwarders" to make better growths and clean their shafts of branches.

Furthermore, from financial considerations, it is well to know that some species develop more rapidly and produce larger quantities of useful material per acre than others; thus the white pine is a "big cropper," and, combining with this a tolerably good shading quality, and being in addition capable of easy reproduction, it is of highest "forest value."

Hence, as the object of forestry is to make money from continued wood crops, use value and forest value must both be considered in the selection of materials for forest planting.

Mutual relationship of different species, with reference especially to their relative height growth and their relative light requirements, must be considered in starting a mixed plantation.

Mixed forest plantations (made of several kinds) have so many advantages over pure plantations (made of one kind) that they should be preferred, except for very particular reasons. Mixed plantations are capable of producing larger quantities of better and more varied material, preserve soil conditions better, are less liable to damage from winds, fires, and insects, and can be more readily reproduced.

The following general rules should guide in making up the composition of a mixed plantation:

a. Shade-enduring kinds should form the bulk (five-eighths to seven-eighths) of the plantation, except on specially favored soils where no deterioration is to be feared from planting only light-needing kinds, and in which case these may even be planted by themselves.

b. The light-needing trees should be surrounded by shade-enduring of slower growth, so that the former may not be overtopped, but have the necessary light and be forced by side shade to straight growth.

c. Shade-enduring species may be grown in admixture with each other when their rate of height growth is about equal, or when the slower-growing kind can be protected against the quicker-growing (for instance, by planting a larger proportion of the former in groups or by cutting back the latter).

d. The more valuable timber trees which are to form the main crop should be so disposed individually, and planted in such numbers among the secondary crop or nurse crop, that the latter can be thinned out first without disturbing the former.

Where a plantation of light-foliaged trees has been made (black walnut, for instance), it can be greatly improved by "underplanting" densely with a shade-enduring kind, which will choke out weed growth, improve the soil, and thereby advance the growth of the plantation.

The selection and proper combination of species with reference to this mutual relationship to each other and to the soil are the most important elements of success.

Availability of the species also still needs consideration in this country; for, although a species may be very well adapted to the purpose in hand, it may be too difficult to obtain material for planting in quantity or at reasonable prices. While the beech is one of the best species for shade endurance, and hence for soil cover, seedlings can not be had as yet in quantity. Western conifers, although promising good material for forest planting, are at present too high priced for general use. Some eastern trees can be secured readily—either their seed or seedlings—from the native woods; others must be grown in nurseries before they can be placed in the field.

Whether to procure seeds or plants, and if the latter, what kind, depends upon a number of considerations. The main crop, that which is to furnish the better timber, had best be planted with nursery-grown plants, if of slow-growing kinds, perhaps once transplanted, with well-developed root systems, the plants in no case to be more than 2 to 3 years old. The secondary or nurse crop may then be sown or planted with younger and less costly material taken from the woods or grown in seed beds, or else cuttings may be used.

In some localities—for instance, the Western plains—the germinating of seeds in the open field is so uncertain, and the life of the young seedlings for the first year or two so precarious, that the use of seeds in the field can not be recommended. In such locations careful selection and treatment of the planting material according to the hardships which it must encounter can alone insure success.

Seedlings from 6 to 12 inches high furnish the best material. The planting of large sized trees is not excluded, but is expensive and hence often impracticable, besides being less sure of success, since the larger-sized tree is apt to lose a greater proportion of its roots in transplanting.

METHODS OF PLANTING.

Preparation of soil is for the purpose of securing a favorable start for the young crop; its effects are lost after the first few years. Most land that is to be devoted to forest planting does not admit of as careful preparation as for agricultural crops, nor is it necessary where the climate is not too severe and the soil not too compact to prevent the young crop from establishing itself. Thousands of acres in Germany are planted annually without any soil preparation, yearling pine seedlings being set with a dibble in the unprepared ground. This absence of preparation is even necessary in sandy soils, like that encountered in the sandhills of Nebraska, which may, if disturbed, be blown out and shifted. In other cases a partial removal of a too rank undergrowth or soil cover and a shallow scarifying or hoeing is resorted to, or else furrows are thrown up and the trees set out in them.

In land that has been tilled, deep plowing (10 to 12 inches) and thorough pulverizing give the best chances for the young crop to start. For special conditions, very dry or very moist situations, special

methods are required. The best methods for planting in the semiarid regions of the far West have not yet been developed. Thorough cultivation, as for agricultural crops, with subsequent culture, is successful, but expensive. A plan which might be tried would consist in breaking the raw prairie in June and turning over a shallow sod, sowing a crop of oats or alfalfa, harvesting it with a high stubble, then opening furrows for planting and leaving the ground between furrows undisturbed, so as to secure the largest amount of drainage into the furrows and a mulch between the rows.

The time for planting depends on climatic and soil conditions and the convenience of the planter. Spring planting is preferable except in southern latitudes, especially in the West, where the winters are severe and the fall apt to be dry, the soil therefore not in favorable condition for planting.

The time for fall planting is after the leaves have fallen; for spring planting, before or just when life begins anew. In order to be ready in time for spring planting, it is a good practice to take up the plants in the fall and "heel them in" over winter (covering them, closely packed, in a dry trench of soil). Conifers can be planted later in spring and earlier in fall than broad-leafed trees.

The density of the trees is a matter in which most planters fail. The advantages of close planting lie in the quicker shading of the soil, hence the better preservation of its moisture and improved growth and form development of the crop. These advantages must be balanced against the increased cost of close planting. The closer the planting, the sooner will the plantation be self-sustaining and the surer the success.

If planted in squares, or, better still, in quincunx order (the trees in every other row alternating at equal distances), which is most desirable on account of the more systematic work possible and the more complete cover which it makes, the distance should not be more than 4 feet, unless for special reasons and conditions, while 2 feet apart is not too close, and still closer planting is done by nature with the best success.

The following numbers of trees per acre are required when planting at distances as indicated:

1½ by 1½ feet	19,360	2 by 4 feet	5,445
1½ by 2 feet	14,520	3 by 3 feet	4,840
2 by 2 feet	10,890	3 by 4 feet	3,630
2 by 3 feet	7,260	4 by 4 feet	2,722

To decrease expense, the bulk of the plantation may be made of the cheapest kinds of trees that may serve as soil cover and secondary or nurse crop, the main crop of from 300 to 600 trees to consist of better kinds, and with better planting material, mainly of light-needing species. These should be evenly disposed through the plantation, each closely surrounded by the nurse crop. It is, of course, understood that not all trees grow up; a constant change in numbers by the death (or else timely removal) of the overshaded takes place, so that the final crop shows at 100 years a close cover, with hardly 300 trees to the acre.

After-culture is not entirely avoidable, especially under unfavorable climatic conditions, and if the planting was not close enough. Shallow cultivation between the rows is needed to prevent weed growth and to keep the soil open, until it is shaded by the young trees, which may take a year with close planting and two or three years with rows 4 by 4 feet apart, the time varying also with the species.

It is rare that a plantation succeeds in all its parts; gaps or fail places occur, as a rule, and must be filled in by additional planting as soon as possible, if of larger extent than can be closed up in a few years by the neighboring growth.

When the soil is protected by a complete leaf canopy, the forest crop may be considered as established, and the after-treatment will consist of judicious thinning.

3. HOW TO TREAT THE WOOD LOT.

In the northeastern States it is the custom to have connected with the farm a piece of virgin woodland, commonly called the wood lot. Its object primarily is to supply the farmer with the firewood, fence material, and such dimension timbers as he may need from time to time for repairs on buildings, wagons, etc.

As a rule, the wood lot occupies, as it ought to, the poorer part of the farm, the rocky or stony, the dry or the wet portions, which are not well fitted for agricultural crops. As a rule, it is treated as it ought not to be, if the intention is to have it serve its purpose continuously; it is cut and culled without regard to its reproduction.

As far as firewood supplies go, the careful farmer will first use the dead and dying trees, broken limbs, and leavings, which is quite proper. The careless man avoids the extra labor which such material requires, and takes whatever splits best, no matter whether the material could be used for better purposes or not.

When it comes to the cutting of other material, fence rails, posts, or dimension timber, the general rule is to go into the lot and select the best trees of the best kind for the purpose. This looks at first sight like the natural, most practical way of doing. It is the method which the lumberman pursues when he "culls" the forest, and is, from his point of view perhaps, justifiable, for he only desires to secure at once what is most profitable in the forest. But for the farmer, who proposes to use his wood lot continuously for supplies of this kind, it is a method detrimental to his object, and in time it leaves him with a lot of poor, useless timber which encumbers the ground and prevents the growth of a better crop.

Our woods are mostly composed of many species of trees; they are mixed woods. Some of the species are valuable for some special purposes, others are applicable to a variety of purposes, and again others furnish but poor material for anything but firewood, and even for that use they may not be of the best.

Among the most valuable in the northeastern woods we should mention the white pine—king of all—the white ash, white and chestnut oak, hickories, tulip tree, black walnut, and black cherry, the last three being now nearly exhausted; next, spruce and hemlock, red pine, sugar maple, chestnut, various oaks of the black or red oak tribe, several species of ash and birch, black locust; lastly, elms and soft maples, basswood, poplars, and sycamore.

Now, by the common practice of culling the best it is evident that gradually all the best trees of the best kinds are taken out, leaving only inferior trees or inferior kinds—the weeds among trees, if one may call them such—and thus the wood lot becomes well-nigh useless.

It does not supply that for which it was intended; the soil, which was of little use for anything but a timber crop before, is still further deteriorated under this treatment, and being compacted by the constant running of cattle, the starting of a crop of seedlings is made nearly impossible. It would not pay to turn it into tillage ground or pasture; the farm has by so much lost in value. In other words, instead of using the interest on his capital, interest and capital have been used up together; the goose that laid the golden egg has been killed.

This is not necessary if only a little system is brought into the management of the wood lot and the smallest care is taken to avoid deterioration and secure reproduction.

IMPROVEMENT CUTTINGS.

The first care should be to improve the crop in its composition. Instead of culling it of its best material, it should be culled of its weeds, the poor kinds, which we do not care to reproduce, and which, like all other weeds, propagate themselves only too readily. This weeding must not, however, be done all at once, as it could be in a field crop, for in a full-grown piece of woodland each tree has a value, even the weed trees, as soil cover.

The great secret of success in all crop production lies in the regulating of water supplies; the manuring in part and the cultivating entirely, as well as drainage and irrigation, are means to this end. In forestry these means are usually not practicable, and hence other means are resorted to. The principal of these is to keep the soil as much as possible under cover, either by the shade which the foliage of the tall trees furnishes, or by that from the underbrush, or by the litter which accumulates and in decaying forms a humus cover, a most excellent mulch.

A combination of these three conditions, viz, a dense crown cover, woody underbrush where the crown cover is interrupted, and a heavy layer of well-decomposed humus, gives the best result. Under such conditions, first of all, the rain, being intercepted by the foliage and litter, reaches the ground only gradually, and therefore does not compact the soil as it does in the open field, but leaves it granular and open, so that the water can readily penetrate and move in the soil. Secondly, the surface evaporation is considerably reduced by the shade

and lack of air circulation in the dense woods, so that more moisture remains for the use of the trees. When the shade of the crowns overhead (the so-called "crown cover," or "canopy,") is perfect, but little undergrowth will be seen; but where the crown cover is interrupted or imperfect, an undergrowth will appear. If this is composed of young trees, or even shrubs, it is an advantage, but if of weeds, and especially grass, it is a misfortune, because these transpire a great deal more water than the woody plants and allow the soil to deteriorate in structure and therefore in water capacity.

Some weeds and grasses, to be sure, are capable of existing where but little light reaches the soil. When they appear it is a sign to the forester that he must be careful not to thin out the crown cover any more. When the more light-needing weeds and grasses appear it is a sign that too much light reaches the ground, and that the soil is already deteriorated. If this state continues, the heavy drain which the transpiration of these weeds makes upon the soil moisture, without any appreciable conservative action by their shade, will injure the soil still further.

The overhead shade or crown cover may be imperfect because there are not enough trees on the ground to close up the interspaces with their crowns, or else because the kinds of trees which make up the forest do not yield much shade; thus it can easily be observed that a beech, a sugar maple, a hemlock, is so densely foliaged that but little light reaches the soil through its crown canopy, while an ash, an oak, a larch, when full grown, in the forest, allows a good deal of light to penetrate.

Hence, in our weeding process for the improvement of the wood crop, we must be careful not to interrupt the crown cover too much, and thereby deteriorate the soil conditions. And for the same reason, in the selection of the kinds that are to be left or to be taken out, we shall not only consider their use value but also their shading value, trying to bring about such a mixture of shady and less shady kinds as will insure a continuously satisfactory crown cover, the shade-enduring kinds to occupy the lower stratum in the crown canopy, and to be more numerous than the light-needing.

The forester, therefore, watches first the conditions of his soil cover, and his next care is for the condition of the overhead shade, the "crown cover;" for a change in the condition of the latter brings change into his soil conditions, and, inversely, from the changes in the plant cover of the soil he judges whether he may or may not change the light conditions. The changes of the soil cover teach him more often when "to let alone" than when to go on with his operations of thinning out; that is to say, he can rarely stop short of that condition which is most favorable. Hence the improvement cuttings must be made with caution and only very gradually, so that no deterioration of the soil conditions be invited. We have repeated this injunction again and again, because

all success in the management of future wood crops depends upon the care bestowed upon the maintenance of favorable soil conditions.

As the object of this weeding is not only to remove the undesirable kinds from the present crop, but to prevent as much as possible their reappearance in subsequent crops, it may be advisable to cut such kinds as sprout readily from the stump in summer time—June or July—when the stumps are likely to die without sprouting.

It may take several years' cutting to bring the composition of the main crop into such a condition as to satisfy us.

METHODS OF REPRODUCING THE WOOD CROP.

Then comes the period of utilizing the main crop. As we propose to keep the wood lot as such, and desire to reproduce a satisfactory wood crop in place of the old one, this latter must be cut always with a view to that reproduction. There are various methods pursued for this purpose in large forestry operations which are not practicable on small areas, especially when these are expected to yield only small amounts of timber, and these little by little as required. It is possible, to be sure, to cut the entire crop and replant a new one, or else to use the ax skillfully and bring about a natural reproduction in a few years; but we want in the present case to lengthen out the period during which the old crop is cut, and hence must resort to other methods. There are three methods practicable.

We may clear narrow strips or bands entirely, expecting the neighboring growth to furnish the seed for covering the strip with a new crop—"the strip method;" or we can take out single trees here and there, relying again on an after-growth from seed shed by the surrounding trees—the "selection method;" or, finally, instead of single trees, we may cut entire groups of trees here and there in the same manner, the gaps to be filled, as in the other cases, with a young crop from the seed of the surrounding trees, and this we may call the "group method."

In *the strip method*, in order to secure sufficient seeding of the cleared strip, the latter must not be so broad that the seed from the neighboring growth can not be carried over it by the wind. In order to get the best results from the carrying power of the wind (as well as to avoid windfalls when the old growth is suddenly opened on the windward side) the strips should be located on the side opposite the prevailing winds. Oaks, beech, hickory, and nut trees in general with heavy seeds will not seed over any considerable breadth of strip, while with maple and ash the breadth may be made twice as great as the height of the timber, and the mother trees with lighter seeds, like spruce and pine, or birch and elm, may be able to cover strips of a breadth of 3 or 4 and even 8 times their height. But such broad strips are hazardous, since with insufficient seed fall, or fail years in the seed, the strip may remain exposed to sun and wind for several years without a good cover and deteriorate. It is safer, therefore, to make the strips no broader than just the height of the neighboring timber, in which case not only has the seed better

chance of covering the ground, but the soil and seedlings have more protection from the mother crop. In hilly country the strips must not be made in the direction of the slope, for the water would wash out soil and seed.

Every year, then, or from time to time, a new strip is to be cleared and "regenerated." But if the first strip failed to cover itself satisfactorily, the operation is stopped, for it would be unwise to remove the seed trees further by an additional clearing. Accordingly, this method should be

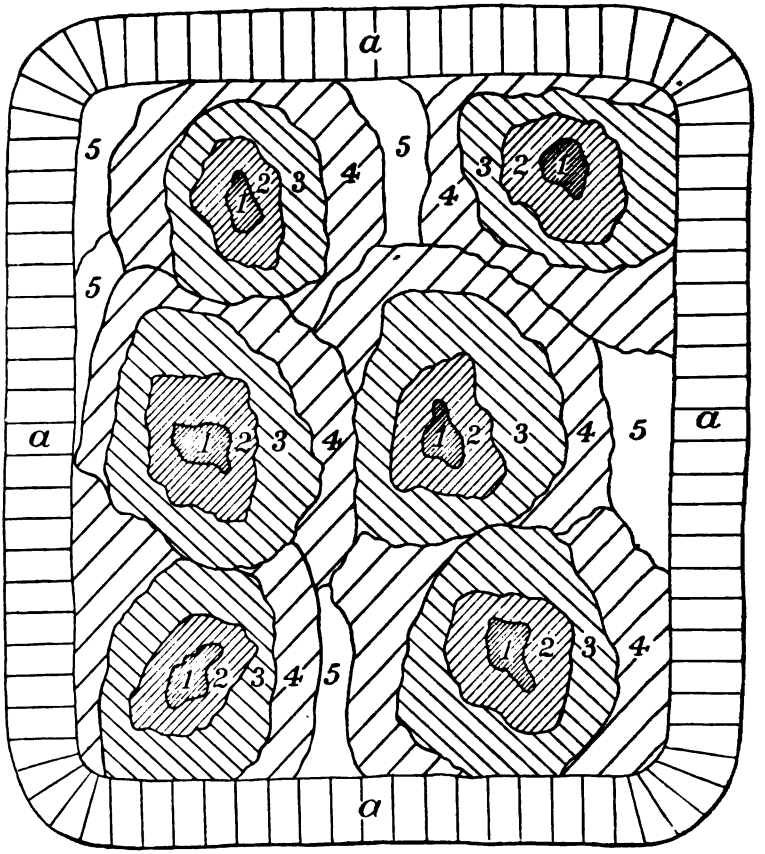

FIG. 13.—Showing plan of group system in regenerating a forest crop. 1, 2, 3, 4, successive groups of young timber, 1 being the oldest, 4 the youngest, 5 old timber; *a*, wind mantle, specially managed to secure protection.

used only where the kinds composing the mother crop are frequent and abundant seeders and give assurance of reseeding the strips quickly and successfully.

The other two methods have greater chances of success in that they preserve the soil conditions more surely, and there is more assurance of seeding from the neighboring trees on all sides.

The selection method, by which single trees are taken out all over the forest, is the same as has been practiced by the farmer and lumberman

hitherto, only they have forgotten to look after the young crop. Millions of seed may fall to the ground and germinate, but perish from the excessive shade of the mother trees. If we wish to be successful in establishing a new crop, it will be necessary to be ready with the ax all the time and give light as needed by the young crop. The openings made by taking out single trees are so small that there is great danger of the young crop being lost, or at least impeded in its development, because it is impracticable to come in time to its relief with the ax.

The best method, therefore, in all respects, is the "*group method*," which not only secures continuous soil cover, chances for full seeding, and more satisfactory light conditions, but requires less careful attention, or at least permits more freedom of movement and adaptation to local conditions (fig. 13).

It is especially adapted to mixed woods, as it permits securing for each species the most desirable light conditions by making the openings larger or smaller, according as the species we wish to favor in a particular group demand more or less shade. Further, when different species are ripe for regeneration at different times, this plan makes it possible to take them in hand as needed. Again, we can begin with one group or we can take in hand several groups simultaneously, as may be desirable and practicable.

We start our groups of new crop either where a young growth is already on the ground, enlarging around it, or where old timber has reached its highest usefulness and should be cut in order that we may not lose the larger growth which young trees would make; or else we choose a place which is but poorly stocked, where, if it is not regenerated, the soil is likely to deteriorate further. The choice is affected further by the consideration that dry situations should be taken in hand earlier than those in which the soil and site are more favorable, and that some species reach maturity and highest use value earlier than others and should therefore be reproduced earlier. In short, we begin the regeneration when and where the necessity for it exists, or where the young crop has the best chance to start most satisfactorily with the least artificial aid. Of course, advantage should be taken of the occurrence of seed years, which come at different intervals with different species.

If we begin with a group of young growth already on the ground, our plan is to remove gradually the old trees standing over them when no longer required for shade, and then to cut away the adjoining old growth and enlarge the opening in successive narrow bands around the young growth. When the first band has seeded itself satisfactorily, and the young growth has come to require more light (which may take several years), we remove another band around it, and thus the regeneration progresses. Where no young growth already exists, of course the first opening is made to afford a start, and afterwards the enlargement follows as occasion requires.

The size of the openings and the rapidity with which they should be enlarged vary, of course, with local conditions and the species which is to be favored, the light-needing species requiring larger openings and quicker light additions than the shade-enduring. It is difficult to give any rules, since the modifications due to local conditions are so manifold, requiring observation and judgment. Caution in not opening too much at a time and too quickly may avoid failure in securing good stands.

In general, the first openings may contain from one-fourth to one-half an acre or more, and the gradual enlarging may progress by clearing bands of a breadth not to exceed the height of the surrounding timber.

The time of the year when the cutting is to be done is naturally in winter, when the farmer has the most leisure, and when the wood seasons best after felling and is also most readily moved. Since it is expected that the seed fallen in the autumn will sprout in the spring, all wood should, of course, be removed from the seed ground.

The first opening, as well as the enlargement of the groups, should not be made at once, but by gradual thinning out, if the soil is not in good condition to receive and germinate the seed and it is impracticable to put it in such condition by artificial means—hoeing or plowing.

It is, of course, quite practicable—nay, sometimes very desirable—to prepare the soil for the reception and germination of the seed. Where undesirable undergrowth has started, it should be cut out, and where the soil is deteriorated with weed growth or compacted by the tramping of cattle, it should be hoed or otherwise scarified, so that the seed may find favorable conditions. To let pigs do the plowing and the covering of acorns is not an uncommon practice abroad.

It is also quite proper, if the reproduction from the seed of the surrounding mother trees does not progress satisfactorily, to assist, when an opportunity is afforded, by planting such desirable species as were or were not in the composition of the original crop.

It may require ten, twenty, or forty years or more to secure the reproduction of a wood lot in this way. A new growth, denser and better than the old, with timber of varying age, will be the result. The progress of the regeneration in groups is shown on the accompanying plan, the different shadings showing the successive additions of young crop, the darkest denoting the oldest parts, first regenerated. If we should make a section through any one of the groups, this, ideally represented, would be like figure 14, the old growth on the outside, the youngest new crop adjoining it, and tiers of older growths of varying height toward the center of the group.

WIND MANTLE.

On the plan there will be noted a strip specially shaded, surrounding the entire plat (fig. 13, *a*), representing a strip of timber which should surround the farmer's wood lot, and which he should keep as dense as

possible, especially favoring undergrowth. This part, if practicable, should be kept reproduced as coppice or by the method of selection, i. e., by taking out trees here and there. When gaps are made, they should be filled, if possible, by introducing shade-enduring kinds, which, like the spruces and firs and beech, retain their branches down to the foot for a long time. This mantle is intended to protect the interior against the drying influence of winds, which are bound to enter the small wood lot and deteriorate the soil. The smaller the lot, the more necessary and desirable it is to maintain such a protective cover or windbreak.

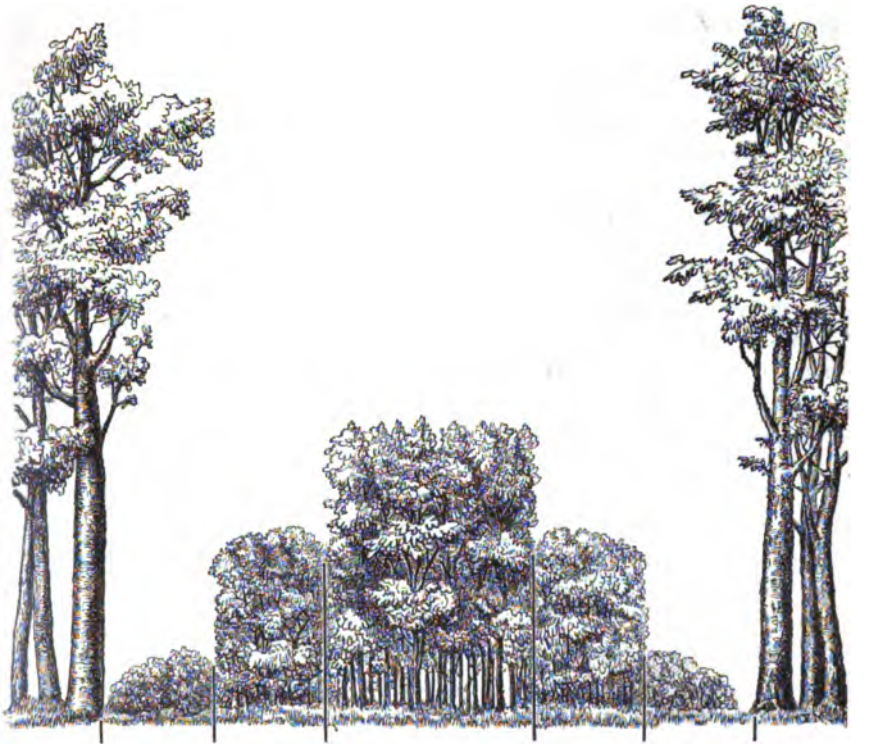

FIG. 14.—Appearance of regeneration by group method.

COPPICE.

Besides reproducing a wood crop from the seed of mother trees or by planting, there is another reproduction possible by sprouts from the stump. This, to be sure, can be done only with broad-leafed species, since conifers, with but few exceptions, do not sprout from the stump. When a wood lot is cut over and over again, the reproduction taking place by such sprouts we call coppice.

Most wooded areas in the Eastern States have been so cut that reproduction from seed could not take place, and hence we have large areas

of coppice, with very few seedling trees interspersed. As we have seen in the chapter on "How trees grow," the sprouts do not develop into as good trees as the seedlings. They grow faster, to be sure, in the beginning, but do not grow as tall and are apt to be shorter lived.

For the production of firewood, fence, and post material, coppice management may suffice, but not for dimension timber. And even to keep the coppice in good reproductive condition, care should be taken to secure a certain proportion of seedling trees, since the old stumps, after repeated cutting, fail to sprout and die out.

Soil and climate influence the success of the coppice; shallow soils produce weaker but more numerous sprouts and are more readily deteriorated by the repeated laying bare of the soil; a mild climate is most favorable to a continuance of the reproductive power of the stump.

Some species sprout more readily than others; hence the composition of the crop will change, unless attention is paid to it. In the coppice, as in any other management of a natural wood crop, a desirable composition must first be secured, which is done by timely improvement cuttings, as described in a previous section.

The best trees for coppice in the northeastern States are the chestnut, various oaks, hickory, ash, elm, maples, basswood, and black locust, which are all good sprouters.

When cutting is done for reproduction, the time and manner are the main care. The best results are probably obtained, both financially and with regard to satisfactory reproduction, when the coppice is cut between the twentieth and thirtieth years. All cutting must be done in early spring or in winter, avoiding, however, days of severe frost, which is apt to sever the bark from the trunk and to kill the cambium. Cutting in summer kills the stump, as a rule. The cut should be made slanting downward, and as smooth as possible, to prevent collection of moisture on the stump and the resulting decay, and as close as possible to the ground, where the stump is less exposed to injuries, and the new sprouts, starting close to the ground, may strike independent roots.

Fail places or gaps should be filled by planting. This can be readily done by bending to the ground some of the neighboring sprouts, when 2 to 3 years old, notching, fastening them down with a wooden hook or a stone, and covering them with soil a short distance (4 to 6 inches from the end. The sprout will then strike root, and after a year or so may be severed from the mother stock by a sharp cut (fig. 15).

For the recuperation of the crop, it is desirable to maintain a supply of seedling trees, which may be secured either by the natural seeding of a few mother trees of the old crop which are left, or by planting. This kind of management, coppice with seedling or standard trees intermixed, if the latter are left regularly and well distributed over the wood lot, leads to a management called "standard coppice." In this it is attempted to avoid the drawbacks of the coppice, viz, failure to produce dimension material and running out of the stocks. The former

object is, however, only partially accomplished, as the trees grown without sufficient side shading are apt to produce branchy boles and hence knotty timber, besides injuring the coppice by their shade.

PLAN OF MANAGEMENT.

In order to harmonize the requirements of the wood lot from a sylvicultural point of view, and the needs of the farmer for wood supplies, the cutting must follow some systematic plan.

The improvement cuttings need not, in point of time, have been made all over the lot before beginning the cuttings for regeneration, provided they have been made in those parts which are to be regenerated. Both the cuttings may go on simultaneously, and this enables the farmer to gauge the amount of cutting to his consumption. According to the

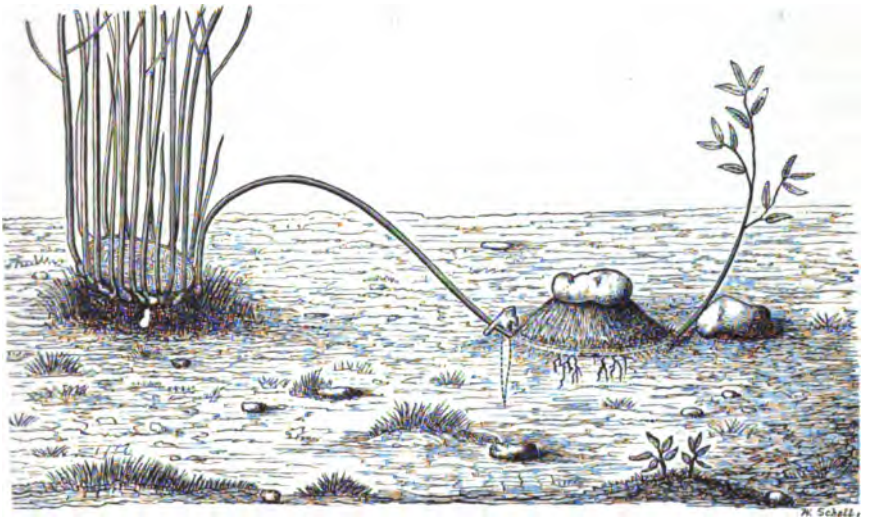

FIG. 15.—Method of layering to produce new stocks in coppice wood.

amount of wood needed, one or more groups may be started at the same time. It is, however, desirable, for the sake of renewing the crop systematically, to arrange the groups in a regular order over the lot.

4. HOW TO CULTIVATE THE WOOD CROP.

Where only firewood is desired, i. e., wood without special form, size, or quality, no attention to the crop is necessary, except to insure that it covers the ground completely. Nevertheless, even in such a crop, which is usually managed as coppice,[1] some of the operations described in this chapter may prove advantageous. Where, however, not only quantity but useful quality of the crop is also to be secured, the development of the wood crop may be advantageously influenced by controlling the supply of light available to the individual trees.

[1] See page 35 for description of coppice.

It may be proper to repeat here briefly what has been explained in previous pages regarding the influence of light on tree development.

EFFECT OF LIGHT ON WOOD PRODUCTION.

Dense shade preserves soil moisture, the most essential element for wood production; a close stand of suitable kinds of trees secures this shading and prevents the surface evaporation of soil moisture, making it available for wood production. But a close stand also cuts off side light and confines the lateral growing space, and hence prevents the development of side branches and forces the growth energy of the soil to expend itself in height growth; the crown is carried up, and long, cylindrical shafts, clear of branches, are developed; a close stand thus secures desirable form and quality. Yet, since the quality of wood production or accretion (other things being equal) is in direct proportion to the amount of foliage and the available light, and since an open position promotes the development of a larger crown and of more foliage, an open stand tends to secure a larger amount of wood accretion on each tree. On the other hand, a tree grown in the open, besides producing more branches, deposits a larger proportion of wood at the base, so that the shape of the bole becomes more conical, a form which in sawing proves unprofitable; whereas a tree grown in the dense forest both lengthens its shaft at the expense of branch growth and makes a more even deposit of wood over the whole trunk, thus attaining a more cylindrical form. While, then, the total amount of wood production per acre may be as large in a close stand of trees as in an open one (within limits), the distribution of this amount among a larger or smaller number of individual trees produces different results in the quality of the crop. And since the size of a tree or log is important in determining its usefulness and value, the sooner the individual trees reach useful size, without suffering in other points of quality, the more profitable the whole crop.

NUMBER OF TREES PER ACRE.

The care of the forester, then, should be to maintain the smallest number of individuals on the ground which will secure the greatest amount of wood growth in the most desirable form of which the soil and climate are capable, without deteriorating the soil conditions. He tries to secure the most advantageous individual development of single trees without suffering the disadvantages resulting from too open stand. The solution of this problem requires the greatest skill and judgment, and rules can hardly be formulated with precision, since for every species or combination of species and conditions these rules must be modified.

In a well-established young crop the number of seedlings per acre varies greatly, from 3,000 to 100,000, according to soil, species, and the manner in which it originated, whether planted, sown, or seeded

naturally.[1] Left to themselves, the seedlings, as they develop, begin to crowd each other. At first this crowding results only in increasing the height growth and in preventing the spread and full development of side branches; by and by the lower branches failing to receive sufficient light finally die and break off—the shaft "clears itself." Then a distinct development of definite crowns takes place, and after some years a difference of height growth in different individuals becomes marked. Not a few trees fail to reach the general upper crown surface, and, being more or less overtopped, we can readily classify them according to height and development of crown, the superior or "dominating" ones growing more and more vigorously, the inferior or "dominated" trees falling more and more behind, and finally dying for lack of light, and thus a natural reduction in numbers, or thinning, takes place. This natural thinning goes on with varying rates at different ages continuing through the entire life of the crop, so that, while only 4,000 trees per acre may be required in the tenth year to make a dense crown cover or normally close stand, untouched by man, in the fortieth year 1,200 would suffice to make the same dense cover, in the eightieth year 350 would be a full stand, and in the one hundredth not more than 250, according to soil and species, more or less. As we can discern three stages in the development of a single tree—the juvenile, adolescent, and mature—so, in the development of a forest growth, we may distinguish three corresponding stages, namely, the "thicket" or brushwood, the "pole-wood" or sapling, and the "timber" stage. During the thicket stage, in which the trees have a bushy appearance, allowing hardly any distinction of stem and crown, the height growth is most rapid. This period may last, according to conditions and species, from 5 or 10 to 30 and even 40 years—longer on poor soils and with shade-enduring species, shorter with light-needing species on good soils—and, while it lasts, it is in the interest of the wood grower to maintain the close stand, which produces the long shaft, clear of branches, on which at a later period the wood that makes valuable, clear timber, may accumulate. Form development is now most important. The lower branches are to die and break off before they become too large. (See illustrations of the progress of "clearing," on pp. 15 and 16.) With light-needing species and with deciduous trees generally this dying off is accomplished more easily than with conifers. The spruces and even the white pine require very dense shading to "clear" the shaft. During this period it is only necessary to weed out the undesirable kinds, such as trees infested by insect and fungus, shrubs, sickly, stunted, or bushy trees which are apt to overtop and prevent the development of their better neighbors. In short, our attention is now devoted mainly to improving the composition of the crop.

[1] If the crop does not, at 3 to 5 years of age, shade the ground well, with a complete crown cover, or canopy, it can not be said to be well established and should be filled out by planting.

WEEDING AND CLEANING THE CROP.

This weeding or cleaning is easily done with shears when the crop is from 3 to 5 years old. Later, mere cutting back of the undesirable trees with a knife or hatchet may be practiced. In well-made artificial plantations this weeding is rarely needed until about the eighth or tenth year. But in natural growths the young crop is sometimes so dense as to inordinately interfere with the development of the individual trees. The stems then remain so slender that there is danger of their being bent or broken by storm or snow when the growth is thinned out later. In such cases timely thinning is indicated to stimulate more rapid development of the rest of the crop. This can be done most cheaply by cutting swaths or lanes one yard wide and as far apart through the crop, leaving strips standing. The outer trees of the strip, at least, will then shoot ahead and become the main crop. These weeding or improvement cuttings, which must be made gradually and be repeated every two or three years, are best performed during the summer months, or in August and September, when it is easy to judge what should be taken out.

METHODS OF THINNING.

During the "thicket" stage, then, which may last from 10 to 25 and more years, the crop is gradually brought into proper composition and condition. When the "pole-wood" stage is reached, most of the saplings being now from 3 to 6 inches in diameter and from 15 to 25 feet in height, the variation in sizes and in appearance becomes more and more marked. Some of the taller trees begin to show a long, clear shaft and a definite crown. The trees can be more or less readily classified into height and size classes. The rate at which the height growth has progressed begins to fall off and diameter growth increases. Now comes the time when attention must be given to increasing this diameter growth by reducing the number of individuals and thus having all the wood which the soil can produce deposited on fewer individuals. This is done by judicious and often repeated thinning, taking out some of the trees and thereby giving more light and increasing the foliage of those remaining; and as the crowns expand, so do the trunks increase their diameter in direct proportion. These thinnings must, however, be made cautiously lest at the same time the soil is exposed too much, or the branch growth of those trees which are to become timber wood is too much stimulated. So varying are the conditions to be considered, according to soil, site, species, and development of the crop, that it is well-nigh impossible, without a long and detailed discussion, to lay down rules for the proper procedure. In addition the opinions of authorities differ largely both as to manner and degree of thinning, the old school advising moderate, and the new school severer thinnings.

For the farmer, who can give personal attention to detail and whose object is to grow a variety of sizes and kinds of wood, the following general method may perhaps be most useful:

First determine which trees are to be treated as the main crop or "final harvest" crop. For this 300 to 500 trees per acre of the best grown and most useful kinds may be selected, which should be distributed as uniformly as possible over the acre. These, then—or as many as may live till the final harvest—are destined to grow into timber and are to form the special favorites as much as possible. They may at first be marked to insure recognition; later on they will be readily distinguished by their superior development. The rest, which we will call the "subordinate" crop, is then to serve merely as filler, nurse, and soil cover.

WHAT TREES TO REMOVE.

It is now necessary, by careful observation of the surroundings of each of the "final harvest" crop trees, or "superiors," as we may call them, to determine what trees of the "subordinate" crop trees, or "inferiors," must be removed. All nurse trees that threaten to overtop the superiors must either be cut out or cut back and topped, if that is practicable, so that the crown of the superiors can develop freely. Those that are only narrowing in the superiors from the side, without preventing their free top development, need not be interfered with, especially while they are still useful in preventing the formation and spreading of side branches on the superiors. As soon as the latter have fully cleared their shafts, these crowding inferiors must be removed. Care must be taken, however, not to remove too many at a time, thus opening the crown cover too severely and thereby exposing the soil to the drying influence of the sun. Gradually, as the crowns of inferiors standing farther away begin to interfere with those of the superiors, the inferiors are removed, and thus the full effect of the light is secured in the accretion of the main harvest crop; at the same time the branch growth has been prevented and the soil has been kept shaded. Meanwhile thinnings may also be made in the subordinate crop, in order to secure also the most material from this part of the crop. This is done by cutting out all trees that threaten to be killed by their neighbors. In this way many a useful stick is saved and the dead material, only good for firewood, lessened. It is evident that trees which in the struggle for existence have fallen behind, so as to be overtopped by their neighbors, can not, either by their presence or by their removal, influence the remaining growth. They are removed only in order to utilize their wood before it decays.

It may be well to remark again that an undergrowth of woody plants interferes in no way with the development of the main crop, but, on the contrary, aids by its shade in preserving favorable moisture conditions. Its existence, however, shows in most cases that the crown cover is not

as dense as it should be, and hence that thinning is not required. Grass and weed growth, on the other hand, is emphatically disadvantageous and shows that the crown cover is dangerously open.

The answer to the three questions, When to begin the thinnings, How severely to thin, and How often to repeat the operation, must always depend upon the varying appearance of the growth and the necessities in each case. The first necessity for interference may arise with light-needing species as early as the twelfth or fifteenth year; with shade-enduring, not before the twentieth or twenty-fifth year. The necessary severity of the thinning and the repetition are somewhat interdependent. It is better to thin carefully and repeat the operation oftener than to open up so severely at once as to jeopardize the soil conditions. Especially in younger growths and on poorer soil, it is best never to open a continuous crown cover so that it could not close up again within 3 to 5 years; rather repeat the operation oftener. Later, when the trees have attained heights of 50 to 60 feet and clear boles (which may be in 40 to 50 years, according to soil and kind) the thinning may be more severe, so as to require repetition only every 6 to 10 years.

The condition of the crown cover, then, is the criterion which directs the ax. As soon as the crowns again touch or interlace, the time has arrived to thin again. In mixed growths it must not be overlooked that light-needing species must be specially protected against shadier neighbors. Shade-enduring trees, such as the spruces, beech, sugar maple, and hickories, bear overtopping for a time and will then grow vigorously when more light is given, while light-needing species, like the pines, larch, oaks, and ash, when once suppressed, may never be able to recover.

Particular attention is called to the necessity of leaving a rather denser "wind mantle" all around small groves. In this part of the grove the thinning must be less severe, unless coniferous trees on the outside can be encouraged by severe thinning to hold their branches low down, thus increasing their value as windbreaks.

The thinnings, then, while giving to the "final harvest" crop all the advantage of light for promoting its rapid development into serviceable timber size, furnish also better material from the subordinate crop. At 60 to 70 years of age the latter may have been entirely removed and only the originally selected "superiors" remain on the ground, or as many of them as have not died and been removed; 250 to 400 of these per acre will make a perfect stand of most valuable form and size, ready for the final harvest, which should be made as indicated in the preceding chapter.

5.—THE RELATION OF FORESTS TO FARMS.

That all things in nature are related to each other and interdependent is a common saying, a fact doubted by nobody, yet often forgotten or neglected in practical life. The reason is partly indifference and partly ignorance as to the actual nature of the relationship; hence we suffer, deservedly or not.

The farmer's business, more than any other, perhaps, depends for its success upon a true estimate of and careful regard for this interrelation. He adapts his crop to the nature of the soil, the manner of its cultivation to the changes of the seasons, and altogether he shapes conditions and places them in their proper relations to each other and adapts himself to them.

Soil, moisture, and heat are the three factors which, if properly related and utilized, combine to produce his crops. In some directions he can control these factors more or less readily; in others they are withdrawn from his immediate influence, and he is seemingly helpless. He can maintain the fertility of the soil by manuring, by proper rotation of crops, and by deep culture; he can remove surplus moisture by ditching and draining; he can, by irrigation systems, bring water to his crops, and by timely cultivation prevent excessive evaporation, thereby rendering more water available to the crop; but he can not control the rainfall nor the temperature changes of the seasons. Recent attempts to control the rainfall by direct means exhibit one of the greatest follies and misconceptions of natural forces we have witnessed during this age. Nevertheless, by indirect means the farmer has it in his power to exercise much greater control over these forces than he has attempted hitherto. He can prevent or reduce the unfavorable effects of temperature changes; he can increase the available water supplies, and prevent the evil effects of excessive rainfall; he can so manage the waters which fall as to get the most benefit from them and avoid the harm which they are able to inflict.

Before attempting to control the rainfall itself by artifice, we should study how to secure the best use of that which falls, as it comes within reach of human agencies and becomes available by natural causes.

How poorly we understand the use of these water supplies is evidenced yearly by destructive freshets and floods, with the accompanying washing of soil, followed by droughts, low waters, and deterioration of agricultural lands. It is claimed that annually in the United States about 200 square miles of fertile soil are washed into brooks and rivers, a loss of soil capital which can not be repaired for centuries. At the same time millions of dollars are appropriated yearly in the river and harbor bills to dig out the lost farms from the rivers, and many thousands of dollars' worth of crops and other property are destroyed by floods and overflows; not to count the large loss from

droughts which this country suffers yearly in one part or the other, and which, undoubtedly, could be largely avoided, if we knew how to manage the available water supplies.

The regulation, proper distribution, and utilization of the rain waters in humid as well as in arid regions—water management—is to be the great problem of successful agriculture in the future.

One of the most powerful means for such water management lies in the proper distribution and maintenance of forest areas. Nay, we can say that the most successful water management is not possible without forest management.

THE FOREST WATERS THE FARM.

Whether forests increase the amount of precipitation within or near their limits is still an open question, although there are indications that under certain conditions large, dense forest areas may have such an effect. At any rate, the water transpired by the foliage is certain, in some degree, to increase the relative humidity near the forest, and thereby increase directly or indirectly the water supplies in its neighborhood. This much we can assert, also, that while extended plains and fields, heated by the sun, and hence giving rise to warm currents of air, have the tendency to prevent condensation of the passing moisture-bearing currents, forest areas, with their cooler, moister air strata, do not have such a tendency, and local showers may therefore become more frequent in their neighborhood. But, though no increase in the amount of rainfall may be secured by forest areas, the availability of whatever falls is increased for the locality by a well-kept and properly located forest growth. The foliage, twigs, and branches break the fall of the raindrops, and so does the litter of the forest floor, hence the soil under this cover is not compacted as in the open field, but kept loose and granular, so that the water can readily penetrate and percolate; the water thus reaches the ground more slowly, dripping gradually from the leaves, branches, and trunks, and allowing more time for it to sink into the soil. This percolation is also made easier by the channels along the many roots. Similarly, on account of the open structure of the soil and the slower melting of the snow under a forest cover in spring, where it lies a fortnight to a month longer than in exposed positions and melts with less waste from evaporation, the snow waters more fully penetrate the ground. Again, more snow is caught and preserved under the forest cover than on the wind-swept fields and prairies.

All these conditions operate together, with the result that larger amounts of the water sink into the forest soil and to greater depths than in open fields. This moisture is conserved because of the reduced evaporation in the cool and still forest air, being protected from the two great moisture-dissipating agents, sun and wind. By these conditions alone the water supplies available in the soil are increased from

50 to 60 per cent over those available on the open field. Owing to these two causes, then—increased percolation and decreased evaporation—larger amounts of moisture become available to feed the springs and subsoil waters, and these become finally available to the farm, if the forest is located at a higher elevation than the field. The great importance of the subsoil water especially and the influence of forest areas upon it has so far received too little attention and appreciation. It is the subsoil water that is capable of supplying the needed moisture in times of drought.

THE FOREST TEMPERS THE FARM.

Another method by which a forest belt becomes a conservator of moisture lies in its wind-breaking capacity, by which both velocity and temperature of winds are modified and evaporation from the fields to the leeward is reduced.

On the prairie, wind swept every day and every hour, the farmer has learned to plant a wind-break around his buildings and orchards, often only a single row of trees, and finds even that a desirable shelter, tempering both the hot winds of summer and the cold blasts of winter. The fields he usually leaves unprotected; yet a wind-break around his crops to the windward would bring him increased yield, and a timber belt would act still more effectively. Says a farmer from Illinois:

> My experience is that now in cold and stormy winters fields protected by timber belts yield full crops, while fields not protected yield only one-third of a crop. Twenty-five or thirty years ago we never had any wheat killed by winter frost, and every year we had a full crop of peaches, which is now very rare. At that time we had plenty of timber around our fields and orchards, now cleared away.

Not only is the temperature of the winds modified by passing over and through the shaded and cooler spaces of protecting timber belts disposed toward the windward and alternating with the fields, but their velocity is broken and moderated, and since with reduced velocity the evaporative power of the winds is very greatly reduced, so more water is left available for crops. Every foot in height of a forest growth will protect 1 rod in distance, and several belts in succession would probably greatly increase the effective distance. By preventing deep freezing of the soil the winter cold is not so much prolonged, and the frequent fogs and mists that hover near forest areas prevent many frosts. That stock will thrive better where it can find protection from the cold blasts of winter and from the heat of the sun in summer is a well-established fact.

THE FOREST PROTECTS THE FARM.

On the sandy plains, where the winds are apt to blow the sand, shifting it hither and thither, a forest belt to the windward is the only means to keep the farm protected.

In the mountain and hill country the farms are apt to suffer from heavy rains washing away the soil. Where the tops and slopes are bared of their forest cover, the litter of the forest floor burnt up, the soil trampled and compacted by cattle and by the patter of the raindrops, the water can not penetrate the soil readily, but is carried off superficially, especially when the soil is of clay and naturally compact. As a result the waters, rushing over the surface down the hill, run together in rivulets and streams and acquire such a force as to be able to move loose particles and even stones; the ground becomes furrowed with gullies and runs; the fertile soil is washed away; the fields below are covered with silt; the roads are damaged; the water courses tear their banks, and later run dry because the waters that should feed them by subterranean channels have been carried away in the flood.

The forest cover on the hilltops and steep hillsides which are not fit for cultivation prevents this erosive action of the waters by the same influence by which it increases available water supplies. The important effects of a forest cover, then, are retention of larger quantities of water and carrying them off under ground and giving them up gradually, thus extending the time of their usefulness and preventing their destructive action.

In order to be thoroughly effective, the forest growth must be dense, and, especially, the forest floor must not be robbed of its accumulations of foliage, surface mulch and litter, or its underbrush by fire, nor must it be compacted by the trampling of cattle.

On the gentler slopes, which are devoted to cultivation, methods of underdraining, such as horizontal ditches partly filled with stones and covered with soil, terracing, and contour plowing, deep cultivation, sodding, and proper rotation of crops, must be employed to prevent damage from surface waters.

THE FOREST SUPPLIES THE FARM WITH USEFUL MATERIAL.

All the benefits derived from the favorable influence of forest belts upon water conditions can be had without losing any of the useful material that the forest produces. The forest grows to be cut and to be utilized; it is a crop to be harvested. It is a crop which, if properly managed, does not need to be replanted; it reproduces itself.

When once established, the ax, if properly guided by skillful hands, is the only tool necessary to cultivate it and to reproduce it. There is no necessity of planting unless the wood lot has been mismanaged.

The wood lot, then, if properly managed, is not only the guardian of the farm, but it is the savings bank from which fair interest can be annually drawn, utilizing for the purpose the poorest part of the farm. Nor does the wood lot require much attention; it is to the farm what the workbasket is to the good housewife—a means with which to

improve the odds and ends of time, especially during the winter, when other farm business is at a standstill.

It may be added that the material which the farmer can secure from the wood lot, besides the other advantages recited above, is of far greater importance and value than is generally admitted.

On a well-regulated farm of 160 acres, with its 4 miles and more of fencing and with its wood fires in range and stove, at least 25 cords of wood are required annually, besides material for repair of buildings, or altogether the annual product of probably 40 to 50 acres of well-stocked forest is needed. The product may represent, according to location, an actual stumpage value of from $1 to $3 per acre, a sure crop coming every year without regard to weather, without trouble and work, and raised on the poorest part of the farm. It is questionable whether such net results could be secured with the same steadiness from any other crop. Nor must it be overlooked that the work in harvesting this crop falls into a time when little else could be done.

Wire fences and coal fires are, no doubt, good substitutes, but they require ready cash, and often the distance of haulage makes them rather expensive. Presently, too, when the virgin woods have been still further culled of their valuable stores, the farmer who has preserved a sufficiently large and well-tended wood lot will be able to derive a comfortable money revenue from it by supplying the market with wood of various kinds and sizes. The German State forests, with their complicated administrations, which eat up 4 per cent of the gross income, yield, with prices of wood about the same as in our country, an annual net revenue of from $1 to $4 and more per acre. Why should not the farmer, who does not pay salaries to managers, overseers, and forest guards, make at least as much money out of this crop when he is within reach of a market?

With varying conditions the methods would of course vary. In a general way, if he happens to have a virgin growth of mixed woods, the first care would be to improve the composition of the wood lot by cutting out the less desirable kinds, the weeds of tree growth, and the poorly grown trees which impede the development of more deserving neighbors.

The wood thus cut he will use as firewood or in any other way, and, even if he could not use it at all, and had to burn it up, the operation would pay indirectly by leaving him a better crop. Then he may use the rest of the crop, gradually cutting the trees as needed, but he must take care that the openings are not made too large, so that they can readily fill out with young growth from the seed of the remaining trees, and he must also pay attention to the young aftergrowth, giving it light as needed. Thus without ever resorting to planting he may harvest the old timber and have a new crop taking its place and perpetuate the wood lot without in any way curtailing his use of the same.

FARMERS' BULLETINS.

These bulletins are sent free of charge to any address upon application to the Secretary of Agriculture, Washington, D. C. Only the following are available:

No. 15. Some Destructive Potato Diseases: What They Are and How to Prevent Them. Pp. 8.
No. 16. Leguminous Plants for Green Manuring and for Feeding. Pp. 24.
No. 18. Forage Plants for the South. Pp. 30.
No. 19. Important Insecticides: Directions for Their Preparation and Use. Pp. 20.
No. 21. Barnyard Manure. Pp. 32.
No. 22. Feeding Farm Animals. Pp. 32.
No. 23. Foods: Nutritive Value and Cost. Pp. 32.
No. 24. Hog Cholera and Swine Plague. Pp. 16.
No. 25. Peanuts: Culture and Uses. Pp. 24.
No. 26. Sweet Potatoes: Culture and Uses. Pp. 30.
No. 27. Flax for Seed and Fiber. Pp. 16.
No. 28. Weeds; and How to Kill Them. Pp. 30.
No. 29. Souring of Milk, and Other Changes in Milk Products. Pp. 23.
No. 30. Grape Diseases on the Pacific Coast. Pp. 16.
No. 31. Alfalfa, or Lucern. Pp. 23.
No. 32. Silos and Silage. Pp. 31.
No. 33. Peach Growing for Market. Pp. 24.
No. 34. Meats: Composition and Cooking. Pp. 29.
No. 35. Potato Culture. Pp. 23.
No. 36. Cotton Seed and Its Products. Pp. 16.
No. 37. Kafir Corn: Characteristics, Culture, and Uses. Pp. 12.
No. 38. Spraying for Fruit Diseases. Pp. 12.
No. 39. Onion Culture. Pp. 31.
No. 40. Farm Drainage. Pp. 24.
No. 41. Fowls: Care and Feeding. Pp. 24.
No. 42. Facts About Milk. Pp. 29.
No. 43. Sewage Disposal on the Farm. Pp. 22.
No. 44. Commercial Fertilizers. Pp. 24.
No. 45. Some Insects Injurious to Stored Grain. Pp. 32.
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No. 51. Standard Varieties of Chickens. Pp. 48.
No. 52. The Sugar Beet. Pp. 48.
No. 53. How to Grow Mushrooms. Pp. 20.
No. 54. Some Common Birds in Their Relation to Agriculture. Pp. 40.
No. 55. The Dairy Herd: Its Formation and Management. Pp. 24.
No. 56. Experiment Station Work—I. Pp. 30.
No. 57. Butter Making on the Farm. Pp. 15.
No. 58. The Soy Bean as a Forage Crop. Pp. 24.
No. 59. Bee Keeping. Pp. 32.
No. 60. Methods of Curing Tobacco. Pp. 16.
No. 61. Asparagus Culture. Pp. 40.
No. 62. Marketing Farm Produce. Pp. 28.
No. 63. Care of Milk on the Farm. Pp. 40.
No. 64. Ducks and Geese. Pp. 48.
No. 65. Experiment Station Work—II. Pp. 32.
No. 66. Meadows and Pastures. Pp 24.
No. 67. Forestry for Farmers. Pp. 48.
No. 68. The Black Rot of the Cabbage. Pp. 22.
No. 69. Experiment Station Work—III. Pp. 32.
No. 70. The Principal Insect Enemies of the Grape. Pp. 24.
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No. 72. Cattle Ranges of the Southwest. Pp. 32.
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No. 77. The Liming of Soils. Pp. 19.
No. 78. Experiment Station Work—V. Pp. 32.
No. 79. Experiment Station Work—VI. Pp. 28.
No. 80. The Peach Twig-borer—an Important Enemy of Stone Fruits. Pp. 16.
No. 81. Corn Culture in the South. (In press.)
No. 82. The Culture of Tobacco. Pp. 23.

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Walter Mulford

RECENT PROGRESS IN TIMBER PRESERVATION.

BY

HERMANN VON SCHRENK,

In Charge of Forest Products, Bureau of Forestry.

[REPRINT FROM YEARBOOK OF DEPARTMENT OF AGRICULTURE FOR 1903.]

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RECENT PROGRESS IN TIMBER PRESERVATION.

By HERMANN VON SCHRENK,
In Charge of Forest Products, Bureau of Forestry.

INTRODUCTION.

During the past year interest in the subject of timber preservation has grown throughout the United States. At the present time there are no less than six large preserving plants under construction or under consideration. The increasing difficulty experienced in getting high-grade timbers, as well as the increasing prices of such timbers, has brought the question of the preservation of woods of lesser resisting powers to the front. In the past the long-lived timbers, like white oak, longleaf pine, and cedar, were employed wherever resistance to decay was an important requisite. As long as these timbers were available in large quantities, it proved most economical to use them. Now that they are much more difficult to get, and consequently more expensive, the question is frequently asked: Is it practicable to use timbers which are not as resistant to decay, but which can be treated chemically; and, if so, what does it cost to treat them, and what length of life is it possible to get?

It is a matter of great importance to all users of timber to know (1) what timbers they can use; (2) how large the supply is; and, (3) how the poorer timbers, when once they are available, can be made more or less decay proof. This subject will therefore be considered from these three standpoints.

TIMBERS WHICH CAN BE TREATED.

Of the inferior timbers, that is, timbers of less decay-resisting powers, which it will probably pay to treat in one way or another, the following is a provisional list:

Some timber trees susceptible of preservative treatment.

NORTHERN AND EASTERN UNITED STATES.	CENTRAL UNITED STATES.	WESTERN UNITED STATES.
Maple.	Red and swamp oaks.	Tamarack.
Beech.	Beech.	Lodgepole pine.
Birch.	Hemlock.	Red fir.
Hemlock.	Tamarack.	Hemlock.
Loblolly pine.	Gum.	Yellow pines.
Red oak family.	Loblolly pine.	True firs.
North Carolina pine.	Cottonwood.	

These timbers are, as a rule, somewhat porous, and consequently, when properly prepared, will allow of a more or less complete penetration of a preservative solution. A large number of them grow with great rapidity and are therefore desirable trees to encourage in any plan involving forest management. Success in the use of any or all of the so-called inferior woods will depend almost entirely on the manner in which they are handled. It is absolutely safe to say to-day that, with proper preliminary preparation and proper treatment with a preservative, any and all of the timbers referred to above can be made to withstand decay for longer or shorter periods, depending upon the kinds of preservatives used.

Attention should be called to the statement that these timbers "will withstand *decay*." Preservative treatment will not protect a timber against *mechanical abrasion*. Red oak or loblolly pine treated with creosote will last indefinitely in the form of a fence post or telegraph

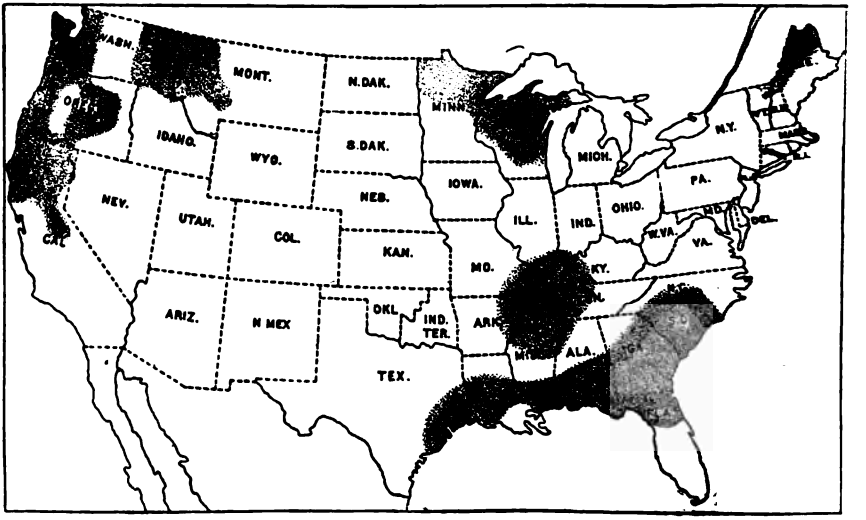

FIG. 46.—Distribution of large sources of timber supply.

pole, but both these timbers will wear out in the form of a railroad tie after a short period unless devices to protect their fibers are adopted. In other words, preservative treatment, as we know it to-day, protects against decay but not against mechanical abrasion.

SUPPLY OF INFERIOR TIMBERS AVAILABLE.

An important consideration which will determine to a large extent whether timber preservation will be practiced, relates to the probable supply of such timbers. While it is not possible to give accurate figures as to the supply of any one timber, it is possible to point out in a general way where the great centers of forest wealth are. A glance at the map (fig. 46) will show this. In the New England States

we can count on considerable quantities of birch, balsam fir, and maple. In the central Mississippi Valley there are large quantities of inferior oaks, beech, and gum. In the South the inferior pines have hardly been touched, while in Wisconsin and Minnesota the tamarack and hemlock are available in large quantities. In the Northwestern States, hemlock, red fir, tamarack, and true firs are found in great abundance. It appears therefore that there are still at hand large supplies of the inferior timbers, and that the centers of supply are widely distributed over the country.

Having found which timbers can be used, it becomes necessary to determine what will constitute a proper preparation for treatment.

HOW TO PREPARE INFERIOR WOODS FOR TREATMENT.

The object of a preliminary preparation for treatment is to make the wood as porous as possible. Most of the woods classed as inferior are more or less open grained, and for this reason are far better suited to preservative treatment than the high-grade timbers, which are denser. Freshly cut wood is full of water, contained largely in cell walls of the wood fiber. In addition to water the wood fibers of the sapwood contain certain small quantities of starches, sugars, albuminous substances, etc. Without going into details (discussed in full in Bulletin No. 41, Bureau of Forestry), it may be said that wood in which these substances are present is rendered less permeable by their presence, that is, most preservatives will not penetrate wood which is wet and full of organic matter. It has been found that the easiest way to make wood more permeable for preservatives is to season it thoroughly, either by ordinary air seasoning or by kiln drying.

The wood should be cut, so far as possible, in the winter period, that is, between October and March. Where possible the bark should be removed, which will not only hasten the seasoning, but will also lessen, if not prevent, insect attack. After the wood has been cut it should be piled in such a way as to allow the greatest amount of air circulation between the various pieces. This holds good whether the wood be for fence posts, telegraph poles, or railroad ties, or is in the form of sawed lumber. During the seasoning process not only does the water evaporate from the timber, but the various starches and albuminous substances are broken down, correspondingly increasing the penetrability of the wood.

The method of piling will depend largely upon the prevalent climatic conditions. In general, however, in extremely dry countries the timber will have to be piled more closely than in rainy countries, to prevent the too rapid drying out and consequent checking of the wood. In rainy countries excellent results have been obtained by building piles so that the upper pieces form a roof. Pl. LIII gives two illustrations of such piling, fig. 1 showing a pile of lumber in a French lumber yard,

and fig. 2 a pile of Baltic pine ties near Berlin, so constructed as to shed the greatest possible amount of water. Pl. LIII, fig. 2, also shows a very useful way of piling timbers in climates where there is a great deal of moisture in the air. This would be applicable in the Gulf States. It will be noted that very little room is taken up, and at the same time the individual pieces of timber touch at very few points, thus permitting air circulation on all sides of the wood. Pl. LIV shows (fig. 1) the best method for piling timber to season it rapidly, and (fig. 2) the simplest and most effective manner of piling telephone poles.

The length of time which is necessary to air-season wood varies with the climate and the season of the year. The tables following and the diagrams (figs. 47 and 48) show this graphically. The curves in the

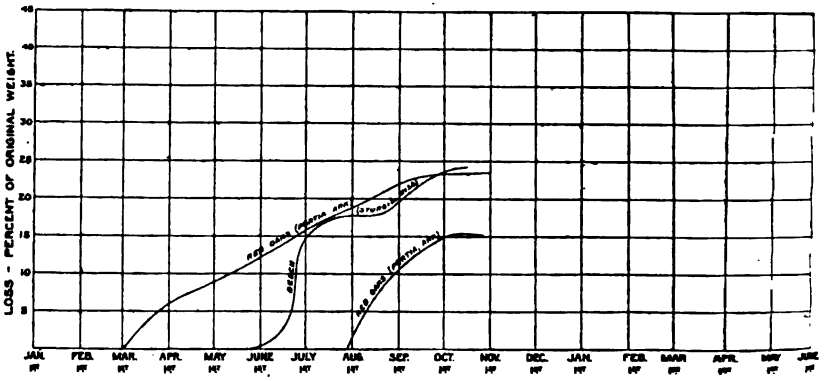

FIG. 47.—Rate of seasoning of red oak.

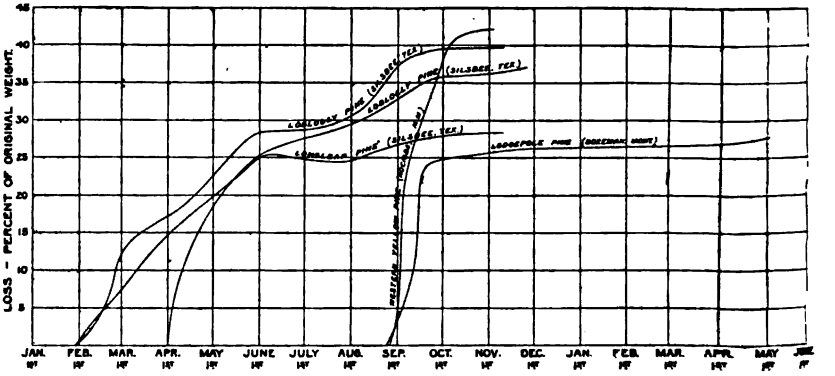

FIG. 48.—Rate of seasoning of loblolly, longleaf, and lodgepole pines.

diagrams show the rate of seasoning during the past year of red oak timber in Arkansas, loblolly and longleaf pines in Texas, and lodgepole pine in Montana.

FIG. 1.—LUMBER PILED TO SHED WATER—FRANCE.

FIG. 2.—BALTIC PINE TIES PILED TO SHED WATER—GERMANY

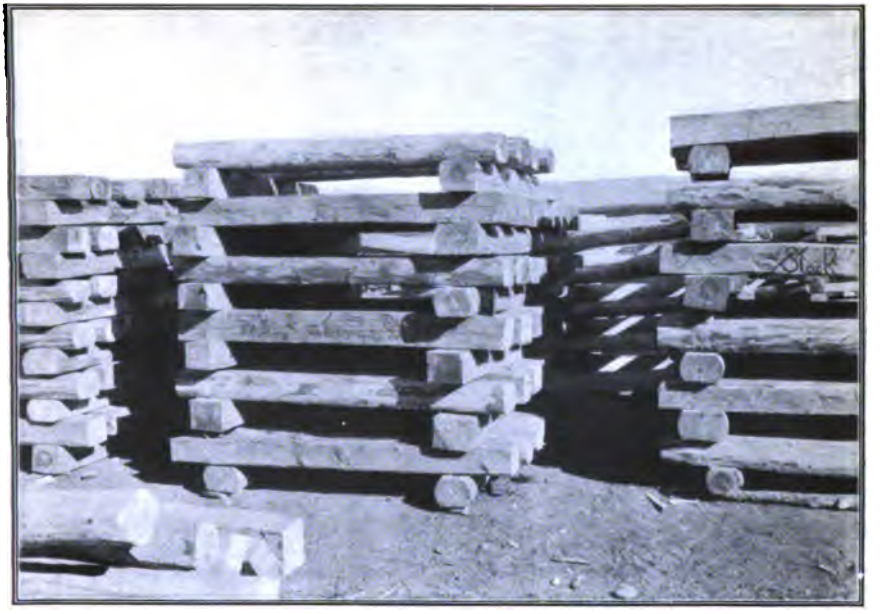

FIG. 1.—HOW TO PILE TIMBER TO SEASON IT RAPIDLY.

FIG. 2.—METHOD RECOMMENDED FOR PILING POLES.

Weights at successive dates of red oak ties cut in June, 1903, at Portia, Ark.

Date of weighing.	Average weight per tie.	Loss.
	Pounds.	*Per cent.*
June 30	184.5	.....
July 18	172.4	6.6
July 28	170.58	7.5
September 10	162.09	12.1
September 20	154.75	16.1
October 28	154.35	16.3

In central New Mexico, where the climate is very dry and hot during the summer, timber dries with great rapidity, as indicated in the following tables:

Weights at successive dates of red pine ties cut in August, 1903, at Rociada, N. Mex.

Date of weighing.	Average weight per tie.
	Pounds.
August 18	184.0
September 3	124.8
September 18	112.1
October 9	107.5
November 5	106.4

Per cent of loss November 5, 42.2.

Weights at successive dates of black pine ties cut in August, 1903, at Rociada, N. Mex.

Date of weighing.	Average weight per tie.
	Pounds.
August 26	164.8
September 3	127.8
September 18	103.0
October 9	96.0
November 6	93.7

Per cent of loss November 6, 43.1.

The cost of holding wood while seasoning is at best a very small one, and in view of the very much improved treatment possible when wood is seasoned this cost need hardly be considered.

TREATMENT OF TIMBER.

The treatment of wood falls into several classes, according to the manner in which the preservative is applied.

Where but few pieces are to be treated, the preservative is often applied to the outside of the wood, either with a brush or by dipping into the preservative. When wood is absolutely dry it will, in many instances, absorb in this way sufficient quantities of preservatives

having any penetrating power, such as tar oils, spirittine, carbolineum, etc. These substances are excellent preservatives, and can be used to protect fence posts, car lumber, sills, and other structural timbers. Great care must be taken, however, that the wood is absolutely seasoned. All tar-oil products should be applied hot. Of the numerous products now being sold, for which the claim is made that they preserve wood absolutely by painting, only a very small number are of any value. Spirittine, carbolineum, and ordinary gas tar may be counted on as excellent wood preservers.

CORROSIVE SUBLIMATE.

The corrosive sublimate method of treating timber consists in immersing the wood in a solution of mercuric chlorid for a period sufficiently long to permit of more or less thorough penetration of the preservative. Excellent results have been obtained by soaking wood in a solution of corrosive sublimate (mercuric chlorid). This process has been extensively used in Europe for many years, particularly for smaller pieces of wood, such as posts, stakes, boards, etc.

The method of operation is extremely simple, and the original cost of the necessary apparatus is very small. A tank or vat is constructed of thick planks, carefully joined together so as to make the tank watertight. No iron must be used in building this vat, since it is quickly destroyed by the mercuric chlorid solution. The wood to be treated, which ought to be seasoned, is piled in this vat, and when the latter is almost full, by means of a series of clamps the wood is held firmly in position. Pl. LV, fig. 1, shows such a tank, into which telephone poles are to be piled. The corrosive sublimate solution is then run in through wooden pipes from a neighboring storage tank, made also of wood. The solution is made by using one part of sublimate to 150 parts of water, the salt being first dissolved in a small quantity of hot water and then diluted to the proper point. The strength of the solution decreases as it is used, and must, therefore, be renewed by adding more sublimate from time to time. The liquid should stand in the vat so that it covers the wood at least an inch. As light affects the solution, it must be kept out by some sort of roof. The wood is left in the vats for from five to ten days, according to the size of the timber. Time should be given for thorough absorption by the wood before it is removed. After the solution has penetrated for a sufficient distance into the timber, the wood is taken out and dried. As the sublimate is comparatively insoluble in water, it remains in the timber for a very much longer time than salts like copper sulphate or zinc chlorid.

Wood treated in this way can be employed with comparative safety for fence posts, stakes for grapevines, etc. The cost of treatment is about 4½ cents per cubic foot of wood. In view of the small expense involved in putting up an apparatus to treat with this process, and the comparatively good results obtained, it is somewhat surprising that it

FIG. 1.—VAT FOR TREATING WOOD WITH CORROSIVE SUBLIMATE.

FIG. 2.—TAR OIL VAT FOR TREATING POSTS.

has not been more generally employed by persons using small quantities of timber, who could not put up an expensive cylinder apparatus, such as is required for treatment with tar oil or zinc chlorid.

CAUTION.—Corrosive sublimate, or mercuric chlorid, is extremely poisonous, and care should be taken to prevent unnecessary handling of the solution, especially by persons not familiar with its character. In case of poisoning, the patient should at once drink milk in large quantities, or water in which well-beaten fresh eggs have been stirred—two to three eggs to a quart of water.

TAR-OIL VAT.

In many instances small pieces of timber, such as fence posts, grapevine stakes, etc., can be treated with tar oil very much after the principle of the corrosive sublimate treatment. A small steel tank is used in many parts of Europe for this purpose. This tank is set in masonry in such a way that a fire can be built under it. Tar oil is poured into the tank, the posts or poles are set vertically in it, and a fire is started under it. As soon as the oil becomes thoroughly warm it penetrates into the timber for smaller or greater distances. Pl. LV, fig. 2, shows such a tank used by the grape growers in southwest Germany to treat vineyard stakes. Experiments on a considerable scale are now under way in this country to determine the exact length of time necessary to bring about a certain penetration, particularly with reference to fence posts. It is expected that preliminary results will be available in the course of three or four months. Attention should be called to the fact that treatment of this kind is possible only with absolutely dry wood.

TIMBER-PRESERVING PLANTS.

Where large quantities of timber are used, expensive and complicated preserving plants have to be built. These consist of steel cylinders in which the timber is placed. The preserving solution is then pumped in and forced into the wood either under pressure or by boiling. Preserving plants of this kind are now being operated at a large number of points in the United States. Such plants should preferably be located at some point where large tracts of land can be purchased cheaply, so as to give enough room for piling to permit of the timber being properly seasoned. On that account it is generally poor policy to construct a plant of this character in or near a large city. Locating the plant at or near the center of the district from which the timber is obtained will not only prevent long shipments, but also will considerably reduce the cost of handling. The size of the plant will depend largely upon the amount of timber to be treated.

The statement on the next page is a general estimate of the approximate cost of preserving plants of different tie-treating capacities. This will, of course, vary with the price of land, cost of steel, etc.

Approximate cost of timber-preserving plants of different capacities.

250,000 ties per year	$40,000 to $50,000
500,000 ties per year	50,000 to 60,000
1,000,000 ties per year	90,000 to 125,000

The majority of treating processes, with the exception of those noted below, use a similar form of apparatus, composed of a close cylinder with a movable door, pumps, tanks, etc. The piping and the pressure limit of the cylinder may differ somewhat in minor details, but the same cylinder can be used both for the zinc chlorid treatment and for the creosote treatment.

COST OF VARIOUS TREATMENTS.

The choice of the kind of treatment to be used will depend (1) on the original cost of the wood; (2) on the cost of treatment; (3) on the increased length of life obtained. Detailed accounts of the methods of treatment will be found elsewhere. At the present time it is of interest, however, to compare briefly the cost of the various treatments. For this purpose the cost of treating railroad ties is taken as a standard, since more attention is now being paid to them than to other classes of material.

CREOSOTING.

Creosoting, as it has been done in the past, is the most efficient and satisfactory method of preserving timber. Well-creosoted wood is known to last indefinitely. Where a high-grade oil is used this treatment will in the long run prove the most satisfactory. At the same time it costs approximately 90 cents to $1 to obtain a creosoted yellow pine tie. The scarcity of creosote, as well as its high price, has prevented its general adoption, but investigations are now under way to secure new sources of supply of this valuable material.

If we compare the actual cost of untreated white oak and creosoted red oak or creosoted loblolly pine, assuming that the untreated tie lasts ten years and the creosoted tie twenty, we may establish the following:

Cost of untreated white oak and of creosoted red oak or loblolly pine ties.

Cost of tie and annual charge.	Untreated white oak (10 years' life).	Creosoted red oak or loblolly pine (20 years' life).
Cost of tie	$0.85	$0.40
Cost of treatment		.45
Total cost of tie	.85	.85
Annual charge on a basis of 4 per cent compound interest	.105	.063
Annual charge for renewal at a cost of $0.19 for handling and placing	.016	.006
Total annual charge	.121	.069

The annual charges of untreated white oak, untreated red oak, and treated red oak are as follows:

For a white oak tie lasting 10 years	$0.121
For a red oak tie lasting 5 years	.124
For a red oak tie creosoted, lasting 20 years	.069

These figures show that there is at this time a considerable saving in using creosoted inferior timbers, and this saving will probably increase as the years go on because of the appreciation in price of white oak, longleaf pine, and other high-grade timbers.

Where oil is used, success is possible only with a good grade of tar oil. To secure this, it is important to have some system of inspection which can be applied to every shipment, which shall be as simple as possible, and which shall effectively test the quality of the oil. The following specifications are now being urged for general adoption by the Bureau of Forestry, and indicate what is considered a high-grade oil by the best European standards:

(1) The tar oil must be clear, that is, there must be no substances in suspension. This is best tested by putting a drop of the oil on a piece of filter paper.

(2) The specific gravity must be about 1.04 to 1.10 at a temperature of 20° C. The boiling points must be as follows: Up to 150° C. nothing must come off; up to 200° C. not more than 10 per cent may come off; up to 235° C. not more than 25 per cent may come off; up to 355° C. at least 90 per cent must come off.

(3) The oil must be soluble in benzene or in absolute alcohol.

Attention is called to the fact that specifications 1 and 2 apply only to oils which are completely liquid at 68° F. (20° C.). Certain high-grade oils made in this country contain amounts of naphthalene and anthracene which render them solid at the temperature above mentioned. The specific gravity of such oils should be taken at 2° above their melting point. It has been found that some of these oils also contain a small amount of matter which is not soluble in benzene or absolute alcohol. This is probably due to the presence of small amounts of free carbon. The presence of one-half of 1 per cent of such insoluble matter should not serve as a sufficient cause for the rejection of the oil. In making use of benzene as a solvent the insoluble portion counted should not include water, which in itself will not dissolve in or mix with benzene. On account of local conditions governing the supply and manufacture of creosote oils, the rejection of any oils should not be made on account of slight variations from the specifications.

Creosoting as it is now conducted in the United States consists of several operations. In the first place the timber is steamed, so as to allow the preserving fluid to penetrate into the wood more readily. The creosote is then forced into the wood under pressure. One

operation takes from eight to twenty-four hours. It has repeatedly been urged by the Bureau of Forestry that when timber is thoroughly seasoned there will be no necessity for the steaming operation. In none of the European creosoting plants is steaming resorted to, and their results as regards the length of life are certainly beyond dispute. Recent tests made with creosote, and also with zinc chlorid solution, a substance of far less penetrating power than creosote, have borne out this contention in every respect, and it is urged that wherever possible the steaming operation should be omitted.

At the present time several new processes for forcing creosote into the wood are being tried. Their purpose is largely to permit of a more economical use of this expensive material. While it is yet too early to give a definite statement as to their value, they may be briefly mentioned.

THE RÜPING PROCESS.

The Rüping process consists in forcing air into absolutely seasoned wood at a pressure of about 5 atmospheres. Without relaxing this pressure the creosote is forced in at a higher pressure, and a pressure of 12 to 14 atmospheres is then maintained for several hours. When the wood has absorbed a sufficient quantity of tar oil all pressure is released. The excess tar oil in the wood is then forced out by the compressed air in it. The total quantity of tar oil absorbed by the wood under this method is very much less than with the ordinary system. Extensive tests are now under way to determine exactly how much of a saving can be effected by the use of this process, which promises to be very successful. It seems very probable at this date that the process can be carried out with very much lower pressures.

VACUUM STEAM PROCESS.

A process is now being tried in Europe which has so far shown excellent results in an experimental way. Absolutely dry wood is placed in a cylinder, and tar oil at a temperature of 70° to 80° C. is run into the cylinder. The oil is left in the cylinder from ten to fifteen minutes, during which time a small quantity is absorbed by the wood. The oil is then pumped out and a high vacuum is maintained for about an hour. At the end of this period steam under pressure of 2 atmospheres is introduced into this vacuum for one to one and one-half hours. The object of this steaming is to cause the small amount of oil which is forced into the wood at first to be more evenly distributed throughout the entire piece. The absorption of oil is extremely variable, depending upon the amount of sapwood in the timber. The process is still in the experimental stage. A slight variation of this process consists in the omission of the vacuum. A small quantity of oil is first pressed into the wood, the oil is then run out of the cylinder, and steam is admitted into the cylinder directly after this operation. This also is still in the experimental stage.

ZINC CREOSOTE PROCESSES.

Efforts are still being made in the direction of preventing the leaching out of zinc chlorid by adding tar oil to the zinc chlorid solution. The so-called Rütgers emulsion process is still used in Germany, but there is considerable objection to it because of the unequal distribution of the tar oil in the cylinders, the pieces of wood at the bottom of the cylinder receiving large quantities of oil while those near the top receive very small quantities.

Certain variations are now being tried by the Berliner Holzcomptoir, who add about 5 per cent of wood tar, obtained from the distillation of beech wood, to the ordinary tar oil. This is said to make an emulsion with the zinc chlorid of a more or less permanent character. In this country the injection of zinc chlorid, followed by tar oil (the Allardyce process), is being used to a certain extent with excellent results. The difficulty with all mixtures of zinc and tar oil is that with a single operation a poor tar emulsion is likely to result, while a double operation makes the treatment more expensive.

The cost of treating a tie with zinc creosote, as compared with the cost of an untreated tie, ignoring tie-plates, and estimating the life of the treated tie at sixteen years, may be given as follows:

Cost of untreated ties and of ties treated with zinc creosote.

Cost of tie and annual charge.	Untreated tie (5 years' life).	Treated tie (16 years' life).
Cost of tie	$0.40	$0.40
Cost of treatment		.25
Total cost of tie	.40	.65
Annual charge on a basis of 4 per cent compound interest	.089	.056
Annual charge for renewal at a cost of $0.19 for handling and placing	.035	.009
Total annual charge	.124	.065

THE SUGAR TREATMENT (POWELLIZED WOOD).

During the past summer an English inventor brought forward a process for treating timber with a strong sugar solution. The wood to be treated is boiled in the solution by introducing steam into a tank, which need not necessarily be a closed one. The boiling stops when all the air has been driven out of the wood. After treating the wood in the tank, it is dried gradually for several days, special care being taken to prevent too rapid evaporation. Three points are claimed for the invention: (1) That the process renders timber tougher and stronger; (2) that green timber can in this way be rapidly seasoned; (3) that the timber is to a certain extent rendered decay proof.

It is probable that this process will prove valuable in the treatment of timber for purposes which will not expose it to moisture. Investigations to determine its actual value are now in progress.

ZINC CHLORID TREATMENT.

The cheapest preserving process, and the one most universally employed in this country, is the treatment with zinc chlorid. The great difficulty with this salt is that it leaches out so rapidly from the wood. Numerous improvements in the manner of treating wood with zinc chlorid have been made in the last year. It has been found that by using absolutely seasoned wood it is possible to treat certain kinds of wood by introducing the zinc chlorid solution directly into the tie without the preliminary and customary steaming. In this connection it is important to remember that the principal object sought is to obtain the greatest possible penetration of the preservative. The amount of dry chlorid absorbed can be regulated easily enough by varying the strength of the solution. For the present the customary 2½ per cent solution is recommended.

The following shows the result of some tests made at the Las Vegas treating plant of the Santa Fe Railway, and may serve as an illustration of the subject just referred to:

Record and results of run.

Vacuum begun	5.50 p. m.
21-inch vacuum	6.50 p. m.
$ZnCl_2$ pumped in	6.50 p. m.
80 pounds pressure reached at	7.15 p. m.
Started forcing back	10.15 p. m.
Completed	10.33 p. m.

Ties weighed morning after treatment.

Total weight of ties before treatment (118 ties used)	pounds	10,602.5
Average weight of ties before treatment	do	89.9
Total weight of ties after treatment (without steaming)	do	21,396.5
Average weight per tie after treatment	do	181.3
Gain per tie	per cent	101.7

If we compare the cost of inferior timber ties, estimating their life as five years, with that of the same kind treated with zinc chlorid, making the very safe assumption of a ten years' life for them, and again with the same number of ties made from long-lived timber, untreated, estimated as giving ten years' service, we get the following approximate figures:

Cost of treated and untreated ties of inferior timber and of untreated ties of long-lived timber.

Cost of tie and annual charge.	Untreated tie.		Treated tie.
	Inferior timber (5 years' life).	Long-lived timber (10 years' life).	Inferior timber (10 years' life).
Cost of tie	$0.40	$0.85	$0.40
Cost of treatment			.16
Total cost of tie	.40	.85	.56
Annual charge on a basis of 4 per cent compound interest	.089	.105	.069
Annual charge for renewal at a cost of $0.19 for handling and placing	.035	.016	.016
Total annual charge	.124	.121	.085
Annual charge for 500,000 ties	62,000	60,500	42,500

The principal points considered may be briefly summed up as follows:

(1) It is more profitable to treat inferior, cheap timbers, such as loblolly pine and red oak, than longleaf pine and white oak, as the latter timbers take treatment very poorly.

(2) It will pay better in the long run to treat these inferior timbers with a preservative, for the annual charge is thereby brought down to a lower point than when untreated timbers are used.

(3) All timbers should be thoroughly seasoned before being treated. Seasoned timber not only takes treatment better and consequently has longer life, but it is also easier to handle.

(4) For the present, the following preservatives are recommended:

FOR FENCE POSTS.—Fence posts, if they are to be preserved, can be either charred or treated when absolutely dry with such substances as carbolineum, spirittine, or tar oil. They can also be soaked in corrosive sublimate. Telegraph and telephone poles can likewise be treated by applying hot tar oil, carbolineum, or spirittine.

FOR STRUCTURAL TIMBER.—When structural timber is to be used in large quantities, and where the odor is not objectionable, this class of material should be treated with creosote, using about 10 pounds of tar oil per cubic foot. Where only a slight protection is necessary, tar-oil products can be applied from the outside provided the wood is absolutely dry.

FOR TIES.—The treatments recommended for ties at present are three:

Creosoting.—The creosote should be of a high grade, as per specifications already given. About 10 pounds of oil should be used per cubic foot.

Zinc chlorid.—Zinc-chlorid treatment is the cheapest recommended at the present time, and the only modification suggested as to its use is the omission of the steaming stage whenever, after sufficient trial, it is found that this can safely be done.

Zinc chlorid and tar oil.—The treatment of porous timber with zinc chlorid, followed by a treatment of 3 pounds of tar oil, is recommended as a process which will give good results.

It is probable that within the next six months one or another of the new processes will have been tested sufficiently to warrant its being recommended.

FOR PILING.—The only treatment recommended for piling is the tar-oil treatment. This is true whether the pile is to be used in structural work on land or for marine work. The only difference between the two is that piling used in marine work ought to have very much more tar oil. The following quantities of tar oil per cubic foot of timber

are recommended: For use in fresh water, 16 to 18 pounds of tar oil; for salt water, in the latitude of New York, 12 to 14 pounds; between New York and Florida, about 20 pounds; and for Gulf points, 22 to 25 pounds. For Pacific coast points larger quantities of oil are required in northern latitudes than for Atlantic coast points; so at Seattle at least 20 to 22 pounds of oil per cubic foot should be used. The tar oil used for marine wash should have a high percentage of naphthalene.

In general, the porous woods should have preference. It will pay better in the long run to use treated loblolly pine for piling than longleaf pine. The unsatisfactory results obtained by many with creosoted piling can almost always be traced to poor treatment with poor material.

Walter Mulford

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U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE.
GIFFORD PINCHOT, Forester.

SUGGESTIONS FOR THE DISPOSAL OF BRUSH IN THE NATIONAL FORESTS.

By

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Walter Mulford

SUGGESTIONS FOR THE DISPOSAL OF BRUSH IN THE NATIONAL FORESTS.

INTRODUCTION.

The piling and burning of brush on the National Forests has been required for the purpose of fire protection, but experience has shown that it is not always advisable. Every case should be considered separately and the question of brush disposal settled according to the special needs of the area in question. This circular has been prepared in the Office of Silvics, and is issued to give supervisors suggestions and to guide them in the experiments they are expected to make to determine the best methods of brush disposal on each Forest.

ADVANTAGES OF BRUSH BURNING.

PROTECTION AGAINST FIRE.

The greatest advantage of brush burning is the protection it gives against fire. In many cases brush burning is the only practicable safeguard against fire. After the average lumbering operation the ground is covered with slash, scattered about or piled just as the swampers have left it. This, in the dry season, is a veritable fire trap. Probably 90 per cent of all uncontrolled cuttings are burnt over, which retards the second crop at least from 50 to 100 years and perhaps permanently changes the composition of the forest. Fires may be set by loggers while still at work on the area, or for several years after by lightning, campers, or locomotives. By piling the brush and burning it in wet weather or in snow, when there is no danger of the fire spreading, all inflammable material is removed, and the second growth can come up without serious risk of being destroyed. Even where only part of the brush is burned and the rest is piled, as when the piles in open places, along ridges, streams, or laid off lines, are burned, very much is gained in case of fire, since these cleared lanes form bases from which a fire may be fought.

Besides lessening the danger from fire, brush burning has certain minor advantages. When the brush on the ground is removed it is much easier for rangers and others to ride or walk through the forest. This may be very important in case of a fire or in rounding up cattle. It is also much easier to cut and handle ties, cordwood, or other timber which may later be taken from the cut-over area if the slash

is out of the way. By piling and burning the green brush as it is cut from the trees by the swampers, as is now being done in Minnesota and parts of Montana, the ground is cleared and skidding is made easier and cheaper. Again, careful piling and burning of brush improves the appearance of the forest. There is nothing much more unsightly than a recently cut-over area where no attempt has been made to dispose of tops and lops. Near towns or resorts and along roads or streams frequented by tourists this point should be carefully considered, but as a general rule the utility of the forest should not be sacrificed for beauty.

PROTECTION AGAINST INSECTS.

Brush burning is often supposed to be a safeguard against noxious insects, but according to information from the Bureau of Entomology this is true only in certain cases and to a limited extent. Some of the most noxious insects do not go into the brush at all, but breed only in the living trees. Others breed only in the top logs or large limbs that are usually left on the ground in brush piling, while still others breed in the brush, but leave it within 30 or 40 days of its being felled. In these cases the ordinary methods of piling and burning brush would do no good in controlling the insects. But some very serious pests remain in the slash all winter, and these, where they are numerous enough to be a menace, can be controlled by fall, winter, or spring burning. Each case needs special regulations, and it is essential that accurate and reliable information on the species and its habits should be secured before brush is burned as a protection against insect pests.

DISADVANTAGES OF BURNING.

The disadvantages of burning brush are many and, with the one exception of protection from fire, far outweigh the advantages. If protection can be had in some other way, as with more efficient patrol service or more stringent laws, the practice should in many cases be abandoned. In many places, especially in the yellow pine type, the best and often the only reproduction comes up under a fallen tree top or other brush. Where there is little of the old stand left, the straggling open top protects the seedlings from the direct heat of the sun. Yet brush not only protects the seedlings from the sun, but, what is more important, the leaves and broken twigs form a cover which retards evaporation of moisture from the soil. Over the greater part of the West the soil dries out very rapidly during the dry season, and this seriously retards or even prevents the growth of seedlings. Even in the moister regions, such as that of the Engelmann spruce type, it is very necessary to conserve the moisture in the soil after logging, to prevent the remaining

trees from being killed through lack of soil moisture. A third reason why seedlings so often come up only under the down tree-tops is that they are protected from stock. Next to drought, sheep are perhaps the most serious menace to reproduction, and though it would be best to keep all stock off the area for several years after logging, in many cases this is not practicable, and on many areas the leaving of the tops on the ground is the only way to protect reproduction from injury.

In many places, after the timber has been cut off, gullies and washes start in the old wheel ruts, log slides, etc., and these and other forms of erosion can best be prevented by leaving the brush on the ground, either laid in the incipient washes or scattered over the soil that is likely to wash. Brush burning destroys the valuable soil cover, and on the spots where the piles are burned the soil is loosened, which renders it even more liable to erosion.

It is well known that where the forest is burned each year the soil becomes poorer and poorer, because nitrogen, the chief fertilizing ingredient of the soil, is given off in the smoke, and only the mineral elements go back to the soil in the ashes. And what is more injurious, the humus, i. e., the decomposed vegetable matter in the top soil, is destroyed. In burning brush after logging, all the fertilizing and humus-forming leaves and twigs are destroyed just when most needed, for another good crop of leaves can not be expected for many years.

The burning of brush not only removes from the soil its natural manure, but renders it unfit for the germination and growth of seedlings. This is especially true of Engelmann spruce. Douglas and white fir also, in the Southwest, will not come up after fire. The area of ground covered by piles for burning varies according to the type and to the density of the forest, but an average of from 5 to 10 per cent of the total area is thus made nonproductive. If full reproduction could be procured on the rest of the area, this would make very little difference, but where reproduction is scattered and hard to procure, as in the Southwest, it would probably make considerable difference in the final stand.

The added cost both to the lumberman and to the Government is another argument against brush burning. The cost of piling brush has varied all the way from 15 cents to $1 or more per M, with an average of 40 or 50 cents, while the cost of burning may be from 5 cents to 25 cents per M, averaging about 15 cents. By abandoning the practice of brush piling this 60 cents a thousand will not be entirely saved, as is claimed by some, for the brush will still have to be lopped and disposed of in some other way, which will cost, it is estimated, at least half as much as piling and burning. But even a saving of 25 or 30 cents a thousand is a strong argument against the practice.

Thus, from a silvicultural view point, the disadvantages of brush burning far outweigh its advantages. Yet as a general policy it seems unwise, until other methods have proved their efficiency, to abandon brush piling and burning to any great extent at present. The fire danger is a known quantity, and though it is being reduced each year, it is still a menace. Therefore changes from the present practice should be made with caution. Brush piling and burning is certainly not advisable in all cases, and extensive experiments should be made to determine what is the best method of brush disposal for the different types and conditions.

BRUSH PILING AND BURNING.

The first care in connection with brush piling should be to see that the trees are felled into the most open ground, away from standing trees and reproduction. By doing this a large part of the cost of piling may be saved. Forest officers should not only tell the piling crew exactly how the brush should be piled, but should lop some boughs and make a few piles for them, explaining at the same time how to choose the place for the pile, how to trim the brush and put it in the pile, and why the larger sticks are left on the ground. A little showing is worth a great deal of telling. In piling brush, all the branches should be lopped so that the main stem of the top lies flat on the ground. The longer limbs should be cut up. Wood over 3 or 4 inches in thickness should not be included in the pile, but should be cut so as to lie evenly on the ground and left to rot. The one exception to this rule is in the case of burning to destroy insects. Then all tops should be included, so that their bark at least shall be scorched. Piles must not be made on down logs or stumps, except in the special case mentioned above, since the charring of green logs prevents their rotting, and dead logs, when they once catch fire, are very hard to put out, and will sometimes burn for days without being noticed, finally to break out into a dangerous fire. For the same reason brush should not be piled near dead standing trees. As a rule brush piles should be from 5 to 10 feet in diameter and from 3 to 5 feet high. Piles should not be nearer to living trees than from 15 to 20 feet; a safer distance would be from 30 to 40 feet. On hillsides the piles can be made nearer to the trees below than to those above them, and nearer to low, small reproduction than to that which is taller.

The Forest officer in charge must be the judge as to how thoroughly the ground should be cleaned. Where reproduction is small and dense, and a running fire would be likely to kill it all, more care in cleaning up broken limbs and rubbish is necessary than where the ground is bare.

The cost of piling varies with the cost of labor, the methods of logging, the type, the topography, the kind of trees cut, and the time

of year it is done. A few figures will illustrate this variation. In the yellow pine type in Montana an addition to the swampers' wages of 15 cents a thousand would, it is said, enable them to pile the brush, as they have to handle it anyway. Usually, however, the piling is done by a separate crew. Much of the work is thus duplicated. In yellow pine in the Southwest brush piling costs from 45 to 50 cents, while in Montana it can be done for 25 cents. One operator in lodgepole in Montana says it is cheaper for him to pile than not to, because he can get his skidding done so much cheaper, yet on other operations it has cost from 50 cents to $1 a thousand, depending on how thoroughly it is cleaned up. In the sugar pine-yellow pine type of California the cost of piling averages from 25 to 35 cents, while the cost in the Douglas fir type in Montana and Idaho averages about 40 cents and in Engelmann spruce type the cost is only about 25 cents a thousand. It is certain, however, that the cost of piling will everywhere be materially reduced when the operators begin to look on piling as part of the swampers' regular work and not as an entirely separate job.

Dry brush should never be burned during the dry season, unless absolutely necessary for the suppression of an insect invasion. Green brush in some places may be burned at any time, but as a rule it is unsafe to burn it in dry weather. The best time to burn brush is in the fall, just after the first snowfall. Then the piles are dry, and there is no danger that the fire will get beyond control. Brush may also be burned at the beginning of *or during* the rainy season, when the ground is damp enough to prevent the fire from spreading and the brush dry enough to burn readily. The number of piles to be lighted at the same time will depend altogether upon local conditions. If there is any danger of the fire spreading it is a good plan to light alternate piles, and when these have burned to fire the intervening ones. This method will lessen and break up the fierce drafts of heated air and flame that often result from burning contiguous piles, and many seedlings and young trees between the piles will be saved which would otherwise be destroyed. Piles should be fired on the side away from the wind. On a hillside the piles at the top should be lighted first.

The methods of setting fire to the piles will vary with weather and other conditions. If the weather is very dry each pile must be set separately, but if it is damp or snowy enough to prevent the fire from spreading, a firebrand may be taken from a lighted pile and carried to the others. A forkful of live coals may be necessary to kindle a water-soaked pile. A four-tined fork will nearly always be found of use in throwing the piles together after they have burned down, or in carrying fire. If much brush is to be burned an ordinary torch or flambeau, such as is used in political or other processions, with a long handle, will be found useful. This can be carried from pile to

pile without danger of sparks spreading fire, and can be thrust into the center of the pile, where the material is driest and most inflammable. A cheap and handy torch, and one that has been found very effective, can be made by wrapping an old piece of burlap or cloth around the end of a stick or iron rod, winding it with wire, and saturating it with kerosene oil.

The cost of brush burning varies like the cost of piling. It varies even more in the same localities, with weather conditions and methods of piling. Brush that can be burned for 10 or 15 cents a thousand at a favorable time, as just after the first snow, will cost five or ten times as much to burn in dry weather or when the piles are very wet. Brush can be burned more easily the first fall after cutting than it can the second year, when many of the leaves have fallen off. Brush burning has been done for 13 cents a thousand in lodgepole in the Medicine Bow, while it has cost 22 cents in similar timber in the Yellowstone, and estimates of 40 cents a thousand have been made for it in the Rockies. It is generally admitted that brush can be most economically burned by the same people who pile it. Recently several contracts have been made in which the purchaser of the timber is required to pile and burn the brush under the direction of Forest officers, as has been the practice in the Minnesota Forest for some time. This will lighten the total cost, and when the weather allows the brush to be burned as logging proceeds the cost of burning will be offset by the subsequent reduction in the cost of skidding.

PILING WITHOUT BURNING.

Brush piled properly, even though it is not burned, is a great protection to the forest. Inflammable material is removed from among the living trees, and should a fire occur it would be much easier to fight. This is especially true where reproduction is dense. Where openings are scarce, piles should be made in the most open places, and may be larger than those made to be burned.

Where the brush is piled but not burned, fire lines should be made at intervals of from a quarter to half a mile through the cut-over area. This can be done by burning the piles in a line from 200 to 300 feet wide. Open ground should be selected, because a better fire line can be made there, and because less reproduction will be injured in the burning. In broken country the best places for fire lines are along trails, roads, ridges, or streams. In more open country they may be made along section and quarter-section lines or where the ground is open and free from reproduction, underbrush, etc. These fire lines need not be straight, but may zigzag to take advantage of the openings.

GROUND BURNING.

Where clear cutting is practiced and fire assists the reproduction that is wanted, ground burning is sometimes advisable. The slash is left scattered as in primitive lumbering operations, and after an efficient fire line has been made around the area it is burned off clean. The fire line should be thoroughly cleaned up before the area is fired. Great care will have to be exercised to prevent the starting of a crown fire, which can not be controlled, even with wide fire lines. The brush should usually be fired against the wind, and should the wind change after the fire is started the brush on the opposite side of the tract should be back fired. This method is the only practical way to secure reproduction of desirable species in some parts of the country.

LOPPING AND SCATTERING.

Where it is best to lop the tops and scatter them over the ground, the lopping should be done thoroughly, so that the top logs and larger branches will lie flat on the ground. If the object is to prevent erosion, the brush should be scattered or roughly piled where washing is most likely to occur. If washing has already started in wheel ruts, log slides, etc., brush should be laid in these as compactly as possible. If good-sized gullies have formed, it is usually better to put the brush in them in compact piles, filling them from side to side, than to scatter some brush all along them. If the chief object in scattering the brush is the conservation of moisture, it should be scattered evenly over the ground within reasonable distance of where it is felled, care being taken to keep the brush at safe distance from reproduction or living trees. Where brush is scattered, fire lines should be made at intervals by piling and burning the brush in lanes 200 or 300 feet wide. This diminishes very greatly the danger from fire, by isolating different areas in the forest, and giving places where back firing can be started. The cost of lopping and scattering brush in this way has not been determined, but it is thought that it can be done for from 50 to 75 per cent of the cost of piling and burning.

FOREST REGIONS OF THE WEST.

The forests of the western United States may be grouped into several more or less definite silvical regions, which are determined chiefly by the amount of rainfall and moisture in the air, though partly by temperature.

This grouping has been followed in this circular, except that the northern and southern Rocky Mountains, which have been usually made two silvical regions, are here combined as one. Methods of handling the brush differ more between types than they do between

the regions. Similar types in different regions can often be handled in the same way, but the different types even in the same region should usually be treated quite differently.

METHODS OF BRUSH DISPOSAL ON DIFFERENT TYPES.

CASCADE REGION.

The Cascade region comprises that part of Washington and Oregon west of the summit of the Cascade Range. It is a region of great humidity and heavy rainfall, so that the question of fire protection is not as important here as in other parts of the West.

Four general types of forest are recognized: Hardwood bottoms, Douglas fir and hemlock type, fir type, and Alpine type. Only the second is of any commercial importance at present.

Hardwood bottoms are the comparatively small areas along the rivers and streams on which maple, cottonwood, and other hardwoods are most abundant, though the principal timber tree is giant arborvitæ (western red cedar). Where this tree is cut, as it often is, for shingles, the brush should be piled, but not burned, or else lopped and scattered carefully. Burning the soil often prevents the reproduction of arborvitæ.

Douglas fir and hemlock type covers the greater part of the slopes and benches below 4,800 feet. At present practically all the lumbering of the region is done in this type. Douglas fir is the most valuable tree and the most abundant, but hemlock, which is a much less desirable species, is able to come up under dense shade and always covers the ground after logging, crowding out the more light-loving Douglas fir. The only way to destroy the hemlock and let the fir come in is to burn the area off after logging. The exposed mineral soil makes an ideal seed bed for Douglas fir, while hemlock will only come up on a vegetable mold. Ground burning should therefore be adopted in this type for three reasons: (1) It is the only way to get Douglas fir reproduction. (2) It is a protection against fire, for by burning off all the brush and débris when the ground and standing timber are too damp to burn, dangerous ground and crown fires, which in this region have been very destructive, are prevented. (3) The stands are so heavy and the amount of brush so great that piling is impracticable in many cases.

Fir type lies above the Douglas fir and hemlock type and is more inaccessible. For this reason, and because the two most important trees comprising it, the noble and amabilis (lovely) firs, are of inferior quality, it has as yet been logged very little.

Alpine type is the scattered timber growth above the fir forest. There is no logging in this type, and probably will not be for many years to come, as there is practically no merchantable timber in it.

SIERRA DISTRICT.

All the forests in central and northern California are included in the Sierra district. Here there is a much lighter rainfall than on the western slope of the Cascades, and the dry spells are more prolonged, so that fire is an important problem.

Four distinct types of forest are recognized: (1) Foothill type, (2) yellow pine-sugar pine type, (3) fir type, (4) Alpine type.

Foothill type is the open stand of various species of oak, together with digger pine, that occurs in the foothills just below the true timber forest. No lumbering is done in this type, and the only cutting likely to occur will be for cordwood or posts. The ground is dry and loose and subject to erosion, and reproduction is hard to get, except under partial shade. Brush should be lopped and scattered over the bare soil, or put in gullies, washes, etc., or piled in long, low piles around the hillside. Only in rare cases should it be burned. Though the danger from fire is great, yet the trees are so scattered that the fire risk would not be greatly increased by leaving the brush unburned, and the advantages of leaving a cover on the ground are very great.

Yellow pine-sugar pine type comprises the bulk of the commercial forest, and in elevation extends from about 1,500 feet up to 5,000 feet in northern California and from about 4,000 feet to 8,000 feet in southern California. Yellow pine and sugar pine are the most important trees numerically and commercially, forming 50 per cent of the entire stand. The danger from fire in this type is so great that every precaution must be taken. Therefore the brush should in nearly all cases be piled and burned. On bare southern slopes, where the soil is loose and easily washed, and where there is no reproduction, it may be best to lop the tops and leave the brush on the ground to protect the soil, in an effort to get reproduction, but fire lines in the slash should always be made if this is done. In dense patches of reproduction the piles might be left unburned if effective fire lines are made.

Fir type.—As the elevation increases, the proportion of yellow pine in the forest decreases, while that of white fir increases until it forms in some places a pure stand. Reproduction of sugar pine and yellow pine must be encouraged at the expense of white fir. There is less danger from fire in the fir type than in the yellow pine-sugar pine type, yet the stands which are lumbered usually contain a large percentage of pine, and the brush should be piled and burned as in the type below it.

Alpine type consists of more or less pure stands of California red fir and of black hemlock, with a scattering of western white pine, and extends from the fir type up to timber line. No cutting is done in the alpine type, and the disposal of brush need not be considered here.

ROCKY MOUNTAIN REGION.

The Rocky Mountain region extends from the Canadian line to southern Utah and Colorado and from the eastern Cascades to and including the eastern slope of the Rockies. The northern part of this region, and especially the northwestern part, differs considerably from the part in Colorado and Utah, and from a silvicultural standpoint it should be divided into two subregions. But since everywhere the main types are the same it can be treated as one region.

Four main forest types are found in the Rocky Mountains: (1) Yellow pine; (2) Douglas fir; (3) lodgepole, and (4) Alpine type. One or two others may be found on restricted areas in a few of the National Forests, but for purposes of brush disposal they can be classed under one of the other types.

Yellow pine type is found on the drier slopes of the lower elevations. The disposal of brush in this type should depend on the reproduction. Where this is good, brush should be piled and burned only where the risk from fire is greatest, but fire lines should be made at intervals. Where reproduction is poor or absent, and this can be attributed to the dense ground cover of grass, brush should be piled and burned. If this is done, the breaks in the turf made by the fires will furnish a starting place for reproduction. Where the soil is bare of both ground cover and reproduction, brush should be lopped and scattered over the area to protect the soil from drying out and washing and to give the seedlings shelter from the sun and protection from cattle.

Douglas fir type occurs throughout the region, but is not often found pure, being mixed with yellow pine, lodgepole, limber pine, etc., and grading into the types above and below it. It occurs above the yellow pine type, requiring rather more moisture than the latter tree. On some forests Douglas fir is the most important tree commercially, while on others, owing to its limited occurrence or poor quality, it is comparatively unimportant. Reproduction as a rule is fair and can usually be secured after logging if proper precautions are taken. Unlike the same tree in the Cascade region, fire hinders reproduction, and burned-over areas are likely to become barren or grow up to lodgepole, a less desirable tree. In this type brush should be piled as a measure of protection, but burned only where the danger from fire warrants it. Fire lines, as recommended for other regions, may be quite sufficient.

Lodgepole type is the one characteristic of the region. It is found in all the forests and is by far the largest and most important one. It occurs naturally above the Douglas fir type, but often extends down through it, especially on old burns. The lodgepole pine is usually in pure stand, but on suitable areas Douglas fir is mixed with it on the

lower elevations and Engelmann spruce on the higher ones. Where these occur the treatment should favor these species. Brush should be piled as far away from these species as possible and burned when snow is on the ground. Where lodgepole is in pure stand, reproduction after logging is certain, and the chief care should be to keep out fire once the seedlings have started. Since reproduction comes up densely after fire, ground burning might be well after clear cutting. This is not recommended, however, since the destruction of humus works injury to the forest. In all cuttings of lodgepole pine, brush should be piled as far as possible from live trees and burned when the snow is on the ground.

Alpine type occurs throughout the Rocky Mountain region at the higher elevations, occasionally extending down the moister canyons and streams into the lodgepole or Douglas fir types below. In the northern part of the region alpine fir is the dominant tree, and the forest is not yet merchantable, so no cutting has been done. Toward the southern part of the region Engelmann spruce gradually becomes the dominant and important tree, till in many forests in Colorado and Utah this tree furnishes the chief part of the saw timber. On account of the high altitude, snow lies late and comes early, so that the fire season is quite short and the danger necessarily lessened. The chief care here should be to conserve the moisture in the soil, since reproduction is usually good. Brush should be lopped and scattered, with occasional fire lines, unless it should be decided that the fire danger is serious, in which case brush should be piled and enough burned to reduce the danger to a minimum.

THE SOUTHWEST.

The forests of New Mexico and Arizona are included in this region, together with those of the southern portions of Colorado, Utah, Nevada, and California. The area is characterized by a very light rainfall and long, hot, dry summers. The danger from fire and the difficulty of obtaining satisfactory reproduction are very great. In deciding on the best method of brush disposal each case must be considered separately, but the question whether the danger from fire is great enough to allow the difficulties of procuring reproduction to be ignored should always be considered. The forests of the Southwest can be divided into four types: (1) Woodland, (2) yellow pine type, (3) Douglas fir type, and (4) spruce type.

Woodland type comprises the scattered forest of oak, juniper, and piñon, usually at elevations of from 5,000 to 6,500 feet and below the true timber belt. Cordwood and posts are about all that is cut here. There is usually an open cover of merchantable trees, with a scattered cover of different species of chaparral, but very little ground cover. Owing to the dryness of the soil, reproduction is sparse.

Here, where the ground is loose and comparatively bare and the slopes steep, the brush should be carefully lopped and scattered over the ground to prevent it from washing and to conserve moisture and protect the reproduction from stock. Where erosion is the chief danger, long low piles built along the side of the hill will prevent washing. Where the ground has already started to wash and gullies are forming or have formed, brush should be piled in them. Usually the cutting is so scattered in this type and the ground cover so slight that there is no need of fire lines. In rare cases, where cattle are scarce, good reproduction is found, with a good ground cover of grass. Here the brush should be piled and burned.

The yellow pine forest occurs above the woodland at elevations of from 6,500 to 8,000 feet. It is usually a pure forest. On many soils, unless very much overgrazed, there is a good ground cover of grass. The way to dispose of brush will depend upon the amount of reproduction and ground cover. Where there is a fair or good stand of reproduction, all brush should be piled and burned, except that where reproduction is very dense the piles should not be burned, since much young growth would be destroyed. Where there is little or no reproduction and the fire risk is not too great, tops should be lopped and scattered.

Douglas fir type occurs at from 8,000 to 9,000 feet elevation and is composed of varying proportions of Douglas and white fir. Usually the stands are fairly dense, with little ground cover and good reproduction, especially of the less desirable white fir. Here the chief danger from fire is within the first two years after logging. After that the leaves fall off the dead branches and the danger is greatly reduced.

All brush should be piled in small compact piles, but only enough piles should be burned to form effective fire lines. Burning the brush injures the soil and prevents the germination of Douglas fir. Wherever burning can be avoided, therefore, it is best not to burn. On steep, densely timbered slopes, where the soil is rich and loose, it would be better to scatter the lopped brush over the ground away from living trees to prevent erosion, and to pile and burn only the necessary fire lines.

Spruce type.—From 9,000 feet up to the limit of commercial timber Engelmann spruce is the dominant tree. It occurs usually in dense stands, with all ages and sizes represented. With it is often a large percentage of alpine fir. The ground is fairly moist and snow comes early and lies late, so that the danger from surface fire is relatively small. There is considerable danger from crown fires, however, and if once burned the forest is permanently destroyed. Here, as a rule, brush should be piled in small piles in the openings as far as possible from trees and reproduction, but burned only in fire lines. In some very dense stands, where the only danger is from crown fires,

it may be best to lop all branches and scatter them evenly over the ground. The brush will be weighted to the ground by the snow and will rot and will much sooner cease to be a menace to the forest than if left in piles.

THE BLACK HILLS.

In the Black Hills region of South Dakota two types of forest are found, spruce type and yellow pine forest.

Spruce type consists of a forest of white spruce sometimes containing a varying per cent of pine and aspen, found on all the moister situations, along stream beds, on northern slopes, and on the highest elevations. As yet very little cutting is being done in this type. On account of the amount of moisture in the soil and the very short dry seasons, with proper fire patrol, there is not any great danger from fire in this type.

Pine type.—By far the greater proportion of the forest in this region is pure yellow pine, and this is the type in which practically all the lumbering is done.

On northern slopes, where there are sufficient seed trees, there is invariably good reproduction. Here brush should be piled to get it from among the young growth, but not burned, except that fire lines should be constructed where the fire danger warrants it. On southern slopes, where the grass makes a dense turf, reproduction is often very poor or absent altogether. Here brush should be piled, and in some places burned, so that the breaks made in the turf by the burned piles may furnish places for the young pine seedlings to start. On dry open slopes, destitute of ground cover and reproduction, brush may be lopped and scattered, to furnish mulch and partial shade to protect the young seedlings; but if this is done fire lines should be constructed.

Strenuous efforts are being made to reduce the depredations of the Black Hills bark beetle, and practically all timber being cut on that forest is infested with these insects. But burning the brush does not destroy these beetles, as they attack only the main stems of living trees and do not go into the branches. By burning the slash many beneficial insects are likely to be destroyed, so that this method of brush disposal is likely to do more harm than good in the matter of holding the bark beetle in check.

MINNESOTA.

Lumbering in the Minnesota National Forest is confined to one type, namely, the white pine-red pine type. Reproduction of these two commercial species is pretty well assured, and the only problem is to keep fires out. For this reason it is best to pile and burn all brush. Burning in winter as the logging progresses has been found the cheapest and most satisfactory method.

Walter Mulford

TESTS ON THE PHYSICAL PROPERTIES OF TIMBER.

BY

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Assistant Forester, Bureau of Forestry.

[Reprint from Yearbook of Department of Agriculture for 1902.]

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TESTS ON THE PHYSICAL PROPERTIES OF TIMBER.

By F. E. OLMSTED,
Assistant Forester, Bureau of Forestry.

OUTLINE OF TIMBER-TESTING WORK IN EUROPE.

From the beginning of the eighteenth to the middle of the present century investigations of the strength of wood received more or less attention, principally from French scientists. Owing to the limited scale upon which the work was done and to the rather crude methods employed, the results were necessarily contradictory and unsatisfactory. In 1848 Chevandier and Wertheim published the results of tests they had made on timber of the Vosges Mountains. This was the first case in which a fairly good history and description of the test material was given, and their results are even now in use.

Most of the modern work in timber testing is founded on that of Dr. H. Nördlinger, chief forester at Hohenheim, Wurttemberg. The results of his investigations were published in 1860. Among the most important tests of recent years are those made by Bauschinger and published at Munich in 1883 and 1887. These tests were made on Scotch Pine and Spruce from the Black Forest, and special attention was given to the conditions under which the timber grew. The main object of the work was to determine the influence of forest conditions and the time of felling on the strength of the wood. In the publication of 1883 the following statements are made, modified by the clause that they should be taken as a near approach to the truth only:

(1) Stems of spruce or pine which are of the same age at equal diameters, and in which the rate of growth is about equal, have the same mechanical properties (when reduced to the same moisture contents), irrespective of local conditions of growth.

(2) Stems of spruce or pine which are felled in winter have, when tested two or three months after the felling, about 25 per cent greater strength than those felled in summer, other conditions being the same.

Bauschinger, in his publication of 1887, further modifies these statements and admits that a great many more tests must be made in order to prove their truth. He agrees in general with Hartig, however, that good conditions of growth produce a good quality of wood.

OUTLINE OF TIMBER-TESTING WORK IN THE UNITED STATES.

In America the most extensive work in timber testing has been done by the Division of Forestry of this Department, and by Mr. T. P. Sharples, in connection with the Tenth Census.

TESTS IN THE TENTH CENSUS.

The tests made for the Tenth Census were very comprehensive, and included work on 412 species; they were not intended, however, to be of practical applicability as accurate data for the strength of the various species. As Mr. Sharples says, "The results obtained are highly suggestive; they must not, however, be considered conclusive, but rather valuable as indicating what lines of research should be followed in a more thorough study of this subject."

TESTS BY THE DEPARTMENT OF AGRICULTURE.

The timber tests made by the Division of Forestry of this Department were begun in 1891 and interrupted in an incomplete state in 1896. The laboratory work was carried on under the supervision of Prof. J. B. Johnson, at St. Louis, and the material was collected from the forest itself with special reference to the conditions under which it was grown. The results, therefore, are of value not only as giving data for the strength value of various woods, but also as indicating the effect of different conditions of locality on the quality of the timber. The tests include 32 species, with 308 trees, furnishing 6,000 test pieces and material for over 45,000 tests; 20,000 pieces were used for physical examination, to determine structure, character of growth, specific gravity, moisture conditions, and other properties. The principal part of the work was done on Southern pines—Longleaf, Cuban, Shortleaf, and Loblolly. Tests were also made on the following species: White Pine, Red Pine, Spruce Pine, Bald Cypress, White Cedar, Douglas Spruce, White Oak, Overcup Oak, Post Oak, Cow Oak, Red Oak, Texan Oak, Yellow Oak, Water Oak, Willow Oak, Spanish Oak, Shagbark Hickory, Mockernut Hickory, Water Hickory, Bitternut Hickory, Nutmeg Hickory, Pecan Hickory, Pignut Hickory, White Elm, Cedar Elm, White Ash, Green Ash, and Sweet Gum. Of these, the greatest number of tests were made on Bald Cypress, White Oak, Cow Oak, Overcup Oak, and Spanish Oak.

Dr. B. E. Fernow, under whose direction the tests were made, makes the following statement in regard to the work:

> As will be observed, some species, like the Southern pines, have been more fully investigated, and the results on these (published in Circular 12, Division of Forestry) may be taken as authoritative. With those species of which only a small number of trees have been tested this can be claimed only within limits and in proportion to the number of tests.

Data are given in Circular No. 15, Division of Forestry, for all these species in the following kinds of tests: Compression endwise, bending

at rupture, bending at relative elastic limit, compression across the grain, and shearing with the grain. The results obtained are in all cases reduced to 12 per cent moisture contents. This was assumed to be the "highest average moisture contents of seasoned wood."

Among other special tests the following were made:

(1) Effect of "bleeding" on Longleaf Pine. The results indicated that the strength was not affected.

(2) Influence of size of the beams on strength. The results indicated that large beams "may be as strong as the small sticks cut from them."

(3) Influence of size in compression members. The results indicated "that columns may be as strong as small compression pieces, and when weaker the presence of internal defects probably accounts for the difference."

(4) To ascertain the effect of hot-air treatment in dry kilns. "The results indicate no detrimental effect, contrary to common opinion."

TESTS AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

Prof. G. Lanza, at the Massachusetts Institute of Technology, has done a considerable amount of timber-test work, and in 1894 published his results in Applied Mechanics. Tests were made on a limited number of Yellow Pine and White Oak columns and spruce pillars and compression tests on White Pine and Yellow Pine posts. Transverse tests to determine the breaking load, modulus of rupture, and modulus of elasticity were made on beams of the following species: Yellow Pine, 52 beams; White Oak, 36; White Pine, 37; Hemlock, 17.

In addition, a series of "time tests" were made on spruce and Yellow Pine; the weights were allowed to remain on the beams for periods of from one month to over a year. From these time tests Professor Lanza draws the conclusion that "the deflection of a timber beam under a long-continued application of the load may be two or more times that assumed when the load was first applied." Professor Lanza is strongly in favor of using sticks of merchantable sizes for testing material as against small pieces. In regard to tests on small pieces he says:

> While a great deal of interesting information may be derived from such tests as to some of the properties of the timber tested, nevertheless such specimens do not furnish us with results which it is safe to use in practical cases where full-size pieces are used. Inasmuch as these small pieces are necessarily much more perfect (otherwise they would not be considered fit for testing), having less defects, such as knots, shakes, etc., than the full-size pieces, they have also a far greater homogeneity. They also season much more quickly and uniformly than full-size pieces. In making this statement, I am only urging the importance of adopting in the experimental work the same principle that the physicist recognizes in all his work, viz, that he must not apply the results to cases where the conditions are essentially different from those he has tested.

MISCELLANEOUS INVESTIGATIONS.

In addition to the investigations mentioned above, timber tests have been made on a small scale in various parts of the country, but owing to lack of system and omission of important details they have but little practical value. Tests on the Southern pines are in a more complete state than those of other species, but it may be stated as a whole that there are to-day no reliable data at hand on the strength of the principal merchantable timbers of the United States. In other words, there are no figures on the strength and durability of American woods which an engineer feels fully justified in applying to his practical work.

TIMBER-TESTING WORK PROPOSED BY THE DEPARTMENT OF AGRICULTURE.

From the foregoing, it is evident that there is an urgent need for reliable data on the strength of American timbers; it is also plain that such data should be obtained according to an exhaustive and systematic plan. Although in many instances wood is being replaced by metal, the former will always hold an important place as a material for constructive and other purposes, and as the supply of timber diminishes, as it is rapidly doing, it becomes more and more necessary to determine its true value, so that it may be used to the greatest economic advantage. There is evidence to show that many of the species which are now classed as "inferior" may with safety take the place of timbers in common favor at the present time. No accurate data whatsoever exist as to the strength of timbers of the Pacific slope; and as these are becoming more and more important and will form the great source of supply in the future, it is desirable that their strength and durability be accurately determined at the present time.

THE INVESTIGATIONS PLANNED.

The Bureau of Forestry of the Department intends to resume the work of timber testing and to conduct the tests on a large scale, in order that the work may eventually include all the principal species of the country. The aim is to obtain results of the greatest practical value to engineers and others directly interested in the utilization of timber. The work will be divided into several series, as follows:

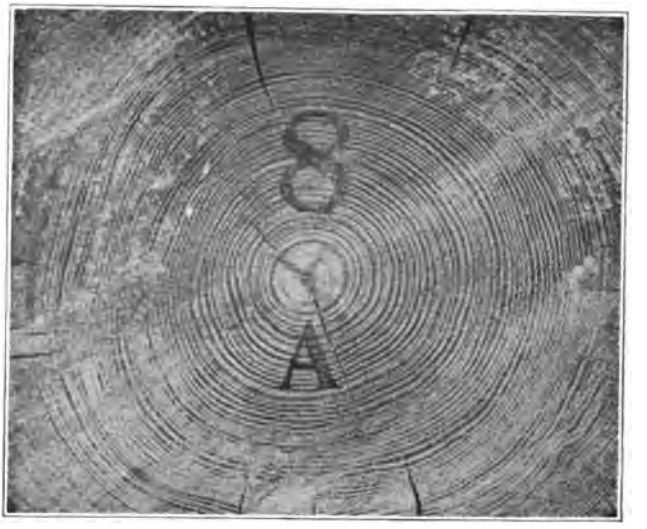
Series I: Tests on timber collected from the open market.

Series II: Tests on timber collected from the forest.

Series III: Tests to determine the effect of moisture and volatile oils on the strength of timber.

Series IV: Tests to determine the effect of preservatives on the strength and durability of timber.

Series V: Tests to determine the effect of kiln-drying methods.



END SECTIONS OF BEAMS FROM LONGLEAF PINE, PHOTOGRAPHED BEFORE TESTING.

BEAMS FROM LONGLEAF PINE.

[No. 1. Large timbers, photographed before testing, 10 by 12 inches by 16 feet; No. 2, break in a large beam after cross-bending test; No. 3, lines of rupture in small beams after cross-bending test.]

Series VI: Tests to determine the effect of the time rate of application of load on the mechanical properties of timber, including impact tests.

This is an exhaustive programme and can be carried out only after many years of work; the results obtained, however, will be fully worth the time and labor.

Results of practical value are expected in the immediate future from Series I, and these tests will be undertaken for the purpose of furnishing reliable data within a short time on the most important species now in common use. Specimens for testing will be purchased in the open market without special regard to the conditions under which the trees grew, and the locality from which they came will be mentioned in a general way only, as "from Berkeley County, S. C.," or "from Lewis County, Wash." It is often impossible to determine the botanical species from an examination of the manufactured timber; in many cases several distinct botanical species are sold under one market name. In this series of tests, therefore, the names of species will be given only so far as practicable, and only those distinctions will be drawn which can be made by the engineer or inspector in practice.

In the tests of Series II, "on timber collected from the forest," there will be no difficulty, of course, in determining the species. The work in connection with these tests will be more difficult and occupy more time than that of the former tests, and will not begin until the Bureau of Forestry is in a position to undertake the work in a thorough manner. This will be an investigation of the greatest importance, and especially of great practical value to the owners of timber lands. A tree is a living thing, and therefore wood, even of the same species, has a much greater variation in strength than iron or other metals. The strength of iron or steel depends upon the manner in which it is manufactured, whereas the strength of wood depends largely upon the conditions under which it grew. By noting such facts as the density of the stand, the nature of the forest mixture, the position of the tree in the forest, and the character of the locality and soil, a relation will be obtained between the strength of the timber and the conditions of growth. The physical properties of the wood also differ according to position in the tree, and this must also be considered. Such an investigation will therefore be of great service to practical forestry, for it will show under what conditions the best quality of timber is produced.

"The effect of moisture and volatile oils on the strength of timber," Series III, is one which will require careful study. It has been found in former tests that timber when moist may be 50 per cent weaker than when comparatively dry. All test material must therefore be reduced to a common degree of moisture contents, and in the case of many species the volatile oils must also be taken into account. For this purpose a method is under consideration which reduces the disks (to

be tested for moisture contents) to shavings. These shavings are placed in an iron retort surrounded by a steam jacket, and through them is passed a current of steam which carries off the volatile oil to a condenser, where it is separated from the water and weighed. To determine the total volatile matter, shavings from the same disk are dried in vacuo until the water is driven off, a stream of dry air being passed through to carry off the volatile matter. From the total volatile matter thus obtained the volatile oils as determined by the first process are deducted, the remainder being the moisture.

Methods of treating wood with various preservatives with a view to prolonging its life are now in common use and are becoming of greater importance every day. But little is yet known as to the effect which such treatment has upon the strength of the timber, and therefore the tests in Series IV will be of particular interest. There is also much difference of opinion about the effect of kiln-drying, and this matter will receive careful attention in Series V.

In Series VI static tests will be made at different time rates of application of loads on large timbers, and both static and impact tests will be made on small selected sticks, of the material and size, for instance, used in carriage manufacture.

In all the tests made according to this general plan special emphasis is to be laid upon the description of the material. There is a wide variation in the quality of timber of any one species, and therefore investigations which do not consider the defects of each stick tested have but little value. All the large beams are photographed on the four sides and both ends, and after testing, a view is taken of the break. (See Pls. LXIX and LXX.) In addition to this a written description of each stick is also made, and the imperfections, amount of sapwood, and rate of growth are noted.

The tests are made at several stations in different parts of the country, and all the work is done according to a uniform plan arranged by the Washington laboratory.

(Dup.) ... Howard.

THE TIMBER RESOURCES OF NEBRASKA.

BY

WILLIAM L. HALL.

Superintendent of Tree Planting, Bureau of Forestry.

[REPRINT FROM YEARBOOK OF DEPARTMENT OF AGRICULTURE FOR 1901.]

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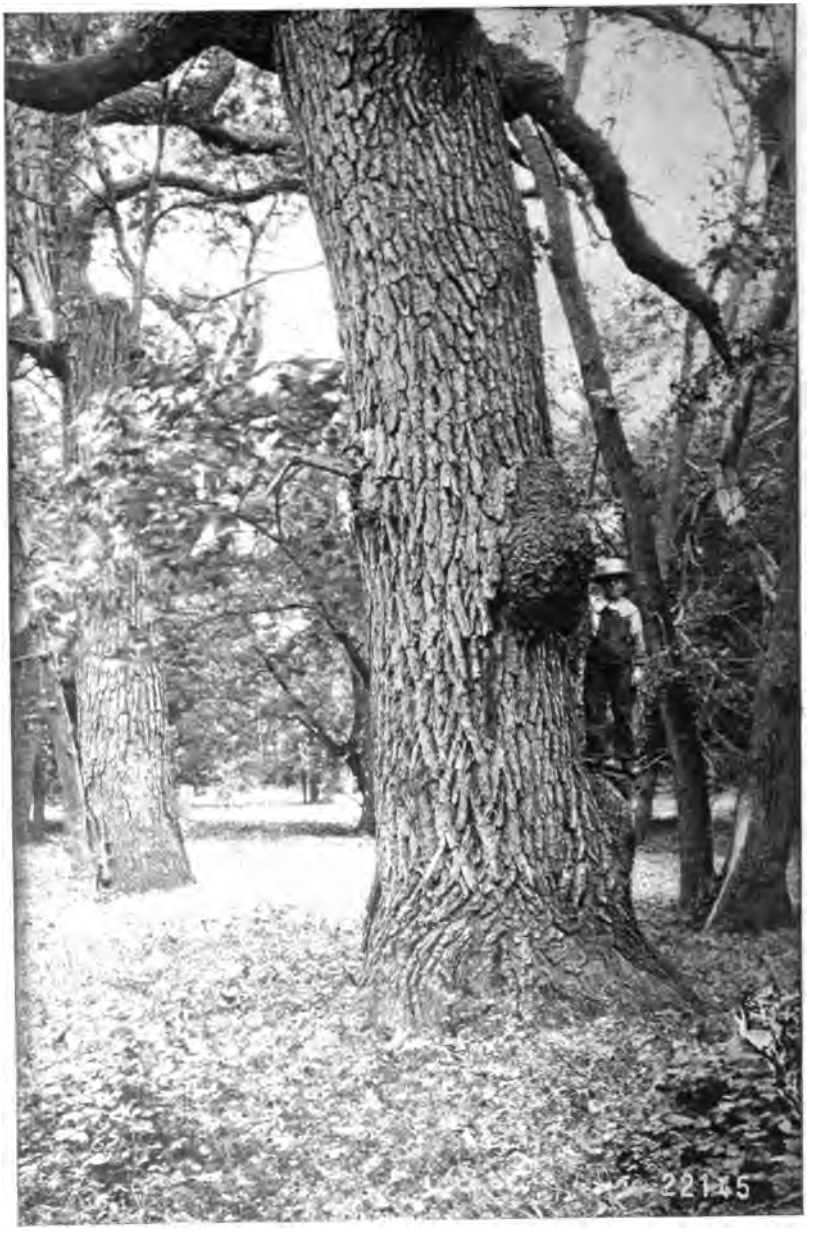


TYPE OF ORIGINAL FOREST.

THE TIMBER RESOURCES OF NEBRASKA.

By WILLIAM L. HALL,

Superintendent of Tree Planting, Bureau of Forestry.

INTRODUCTION.

In no other State is the ratio of planted to natural timber so close as regards area and usefulness as in Nebraska. The comparatively small area of natural timber and the large area of planted timber bring the two into the unusually close ratio of 1 acre of planted to 8 acres of natural forest. Nearly all the latter is composed of young growth, and its chief interest lies in its rapid extension in area and improvement in quality. What the planted timber lacks in area it makes up by more even distribution throughout the State and more convenient location for a large number of uses.

THE NATURAL TIMBER PRIOR TO SETTLEMENT OF STATE.

The original wooded area of Nebraska is estimated at 2,300 square miles, or only 3 per cent of the State's area. One-half of this timber covered the bluffs of the Missouri River or skirted the streams flowing into it, and one-sixth bordered the tributaries of the Blue River; the remaining portion was found in the canyons and on the bluffs in the western part of the State. The combination of adverse natural conditions, together with fire, held the forest within these limits.

The number of species composing this original growth was limited. Some 56 species were found in the extreme eastern edge of the State, along the Missouri River, but going westward one after another of these disappeared until, in the central part of the State, there were but 13 or 14 species. In the western part the number increased again to 22 or 23.

In quality the original timber of Nebraska was not first class. (See Pl. IX.) The extreme eastern part of the State contributed to the sawmill some hardwoods, such as oak, walnut, and elm; the valleys of the central part a little Cottonwood, and Pine Ridge, near the northwest corner of the State, a considerable portion of Yellow Pine. Excepting the pine, only the timber produced in moist and otherwise favorable places was of good form for lumber. Elsewhere the trees grew too far apart to have good form.

IMPROVEMENT IN THE NATURAL TIMBER SINCE SETTLEMENT OF STATE.

With the settlement of the State came a change in conditions which resulted in a modification of forest growth and distribution. Fires became less frequent, the trampling of buffalo ceased, and domestic animals were confined to fenced inclosures. Freed from these destructive agencies the forest sprang into more vigorous growth, and soon began to encroach upon the adjacent prairie.

This change in forest growth has been closely studied by Dr. Charles E. Bessey, who describes it as follows:

> I have been studying the tree areas of eastern Nebraska, and find evidence that they are advancing with a good deal of rapidity. My personal observations have been in so many localities that it is impossible to specify them in detail. * * * They involve most of the counties in eastern Nebraska. In practically every case where one travels up the streams, passing out to the side branches, to the little temporary rills which water the upper basins, the trees are of smaller size and are much younger. It is a very rare occurrence to find large trees near the upper end of a forest belt. I have seen a few such cases, but their rarity is such that one is always surprised when they are found. The general rule is that near the upper limit of the tree area there are many shrubs, and mingled with them many young trees no larger than those which, under cultivation, are known to be not more than 15 to 20 years old. I may cite the following localities from my notes: (1) On the head waters of Oak Creek in Butler County; (2) head waters of the Blue River in Seward and Hamilton counties; (3) head waters of Weeping Water Creek in Cass County; (4) along small streams in the Loup Valley; (5) along the small streams north of the Platte in Sarpy County; (6) head waters of Little Nemaha Creek in Nemaha County.
>
> No one who has seen and studied the forest areas in eastern Nebraska will be able to doubt that they are spreading where they are given a fair opportunity and are not prevented by man or his domestic animals.[1]

The improvement in the natural forest is evident in three ways: (1) By extension over new territory; (2) by increase in density in the territory already covered; (3) by improved form of the trees.

GAIN IN AREA.

The extent to which the forest has taken possession of new ground during the half century since settlement began can be estimated only imperfectly. Along almost every stream and ravine the forest has won some ground from the prairie. Here it has been only a few square rods, there several acres. Not infrequently tracts of 80 or 100 acres have changed from prairie to forest. Near the farm of Mr. C. H. Barnard, of Table Rock, a field which twenty-five years ago was without timber and under cultivation is now covered by a dense forest of young timber. In another place, not a mile distant, the forest has extended up a ravine 2 miles beyond its limit of twenty-five years ago. Eastern Nebraska is penetrated by many small streams and ravines, so that the little gained on each one amounts to a great deal in the

[1] Paper read before Section G, Botany, of the American Association for the Advancement of Science, 1899.

FIG. 1.—NATURAL FOREST ON LAND UNDER CULTIVATION TWENTY-FIVE YEARS AGO. PAWNEE COUNTY, NEBR.

FIG. 2.—A VIGOROUS YOUNG FOREST. BROWNVILLE, NEBR.

aggregate. It is probably not too much to say that in eastern Nebraska the forest has occupied new ground to the extent of 400 square miles. This is not a net gain in forest area, for it has been partly offset by clearing and pasturage. But with all losses considered the gain has been large. Nor is the growth now confined to streams and ravines as it was once. It appears in every protected place. The following species in that region, the forerunners of larger growth, are coming up in dense thickets along fence rows and roadsides: *Rhus glabra*, *Ribes gracile*, *Rubus occidentalis*, *Symphoricarpus vulgaris*, *Prunus virginiana*, *Cornus asperifolia*, *Rhamnus lanceolata*.

The tendency is for timber to occupy with more or less rapidity all land in the extreme eastern part of Nebraska not devoted to farming and grazing, and the transition is taking place more rapidly now than ever before, because of improved soil and moisture conditions and augmented seed production, due to the increase of bearing trees.

GAIN IN DENSITY.

There has been a gain also in the density of the forest. Originally it consisted of a sparse stand of mature trees with no young growth. (See Pl. X.) The change has been wonderful. With the absence of fires, seedlings grew up densely among the mature trees. Oftener than not the latter were cut out, giving the young timber undisputed possession.[1] An instance of this is to be seen on the farm of Mr. J. O. Lansing, 2 miles west of South Bend. When this farm was purchased, sixteen years ago, all the mature timber had been cut for fuel and posts. The land was fenced and fires excluded, and now there is a dense growth of young timber, all under 20 years old. Nearly all the timber of eastern Nebraska consists of just such vigorous, thick growth under 40 years of age. While it has not reached size for lumber, it is valuable for fuel, posts, and poles. It is probable that the gain in density is even greater than the gain in area.

GAIN IN QUALITY.

The removal of old timber was after all the best course. The mature trees out of the way, the young timber had opportunity to occupy the ground in a dense, even stand. In consequence, its growth is straight and slender; much of it has cleared itself of side branches, and before many years will be of size for saw timber.

The increase and improvement in the natural timber are direct results of settlement and cultivation, and have taken place in the exact ratio with the protection given. Wind, water, birds, and animals

[1] So rapidly were the mature trees cut that in many places the last vestige was removed in a few years. It seemed that the small supply of timber was to be exterminated, for at that time there was no indication of the wonderful reproductive tendency apparent in recent years.

disseminated the seeds from which the trees came, but man protected and encouraged the growth. The natural timber of the present time is, therefore, due almost entirely to his care.

VALUE OF THE NATURAL TIMBER OF NEBRASKA.

The value of the young timber can scarcely be overestimated. Besides its beneficial climatic influence, it has great value on account of the fuel and lumber it will furnish. Its economic value is emphasized by the fact that for the most part it occupies land which, on account of proximity to streams and ravines, is not available for other agricultural crops.

The farm of Hon. J. Sterling Morton, 1 mile west of Nebraska City, affords a notable example of the value of the natural timber under a good system of management. This farm in 1855 included 56 acres of brush land which was of little value for agricultural crops on account of the circuitous course of a small stream which penetrated it. A course of thinning and improvement cutting, at once undertaken and since adhered to, has for forty-five years resulted in an annual product of $200 worth of firewood and posts, or a total sum of $9,000. The cutting and pruning constantly improved the character of the timber. The trees are now better in form, stand, and reproduction than at any previous time, and represent a value of several thousand dollars. (See Pl. XI.)

In many instances the encouragement of the natural timber has paid better than planting.

THE PLANTED TIMBER OF NEBRASKA.

Many estimates have been made of the area of the planted timber in Nebraska. Some of these are accurate to a certain degree, but they do not convey a vivid impression of the actual well-planted condition of the State. The fact becomes far more impressive when one passes through the State and observes the almost countless groves on every side. Nearly every farm has its plantations. Even these do not represent the planting actually done, for unfortunately a great deal of it was done wrong, and there is now little or nothing to show for it. Then, in some localities there have been heavy losses on account of adverse conditions of soil and moisture. Yet, in spite of losses, Nebraska has over 200,000 acres of planted timber, and has honestly won the title of "The tree planting State."

While the planted timber is unequal in area to the natural timber, and, as a rule, is inferior to it in thrift and quality, it has had greater influence than the natural timber in changing the appearance of the State from unbroken prairie to a combination of farm and woodland. It has already been pointed out that the natural timber occupies the low land along the streams and ravines. Looking across the country, the natural timber is often entirely hidden from view, or else so

FIG. 1.—NATURAL FOREST GROWTH OF THE LAST FORTY-FIVE YEARS. NEBRASKA CITY, NEBR.

FIG. 2.—YOUNG NATURAL FOREST. NEBRASKA CITY, NEBR.

obscured that its importance is not fully recognized. On the other hand, the planted timber, usually near or about the farmstead, nearly always occupies a commanding situation on the higher slopes or the uplands, where its extent, size, and prominence are considerably magnified. Thus, the casual observer receives his impression almost entirely from the planted timber.

VALUE OF THE PLANTED TIMBER OF NEBRASKA.

GENERAL UTILITY.

The fact that the trees are located in conjunction with the farmstead gives the planted timber distinctive value in several ways. If located advantageously, it serves a very useful purpose in modifying the climate of the farmstead. Climate is the sum total of weather influences. Wind, sunshine, temperature, and atmospheric humidity are important factors. Whatever modifies one of these factors modifies climate. The climate of Nebraska is somewhat rigorous on account of wind and extremes of temperature, so that a regulation of these features by any means is desirable.

The benefits derived from a body of timber planted in connection with the farmstead are principally the following:

WIND PROTECTION.—It gives protection from the wind. This is important at all seasons of the year. In summer, by checking the wind, it retards the evaporation of moisture from the soil in gardens, orchards, and near-by fields. In the same way it prevents the loss of fruit and breakage of orchard trees and protects the buildings from the violent gales that occur with great frequency on the plains. In many cases trees alone have saved buildings from destruction by hurricanes.

Its value in winter is equally pronounced. At that time the orchard is so susceptible to injury from high wind that the loss of the fruit crop and even damage to the trees as a result of winter storms are frequent occurrences in the unprotected orchard. Many orchardists regard profitable fruit growing on the plains as dependent almost entirely upon the protection of the trees by wind-breaks. Protection to the buildings and farm animals in winter is also important. Unprotected houses require more fuel than protected ones. Unsheltered live stock of any kind require more feed than those which are sheltered, though the shelter be nothing more than a grove of trees, and, even with increase of feed, unsheltered animals will shrink in flesh during winter storms. Trees, properly located, will prevent many serious losses of this character.

SHADE.—Plantations of trees protect the farmstead from the direct sun, which is often extremely disagreeable. One of the most impressive things on the high unsettled prairies in summer is the utter lack

of shade. For miles and miles one may seek in vain for a moment's shelter from the uninterrupted sunshine. Even the grasshoppers seek to protect themselves from the burning heat by creeping into the meager shade of fence posts and tufts of grass.

There are still some dooryards in Nebraska entirely without shade trees; but compared with those which have them, the number is small. The value of shade for the comfort of the dooryard, walks, and drives, and also for the protection of domestic fowls and farm animals, can hardly be overestimated.

FUEL.—The planted timber supplies fuel which is much needed. Nebraska has no coal deposits, and the small area of its natural timber gives an insufficient supply of fuel. Wood and coal must be shipped from the nearest sources of supply, which, for some localities, are 400 or 500 miles distant. Moreover, the high price of wood and coal compels many to economize in their use by substituting other materials, such as corncobs, and, in years of plenty, corn in the ear. But in recent years many farmers have reaped the benefits of previous forethought and labor in obtaining from their planted groves an abundance of fuel for home use. Such saving often amounts to over $100 per year on a single farm.

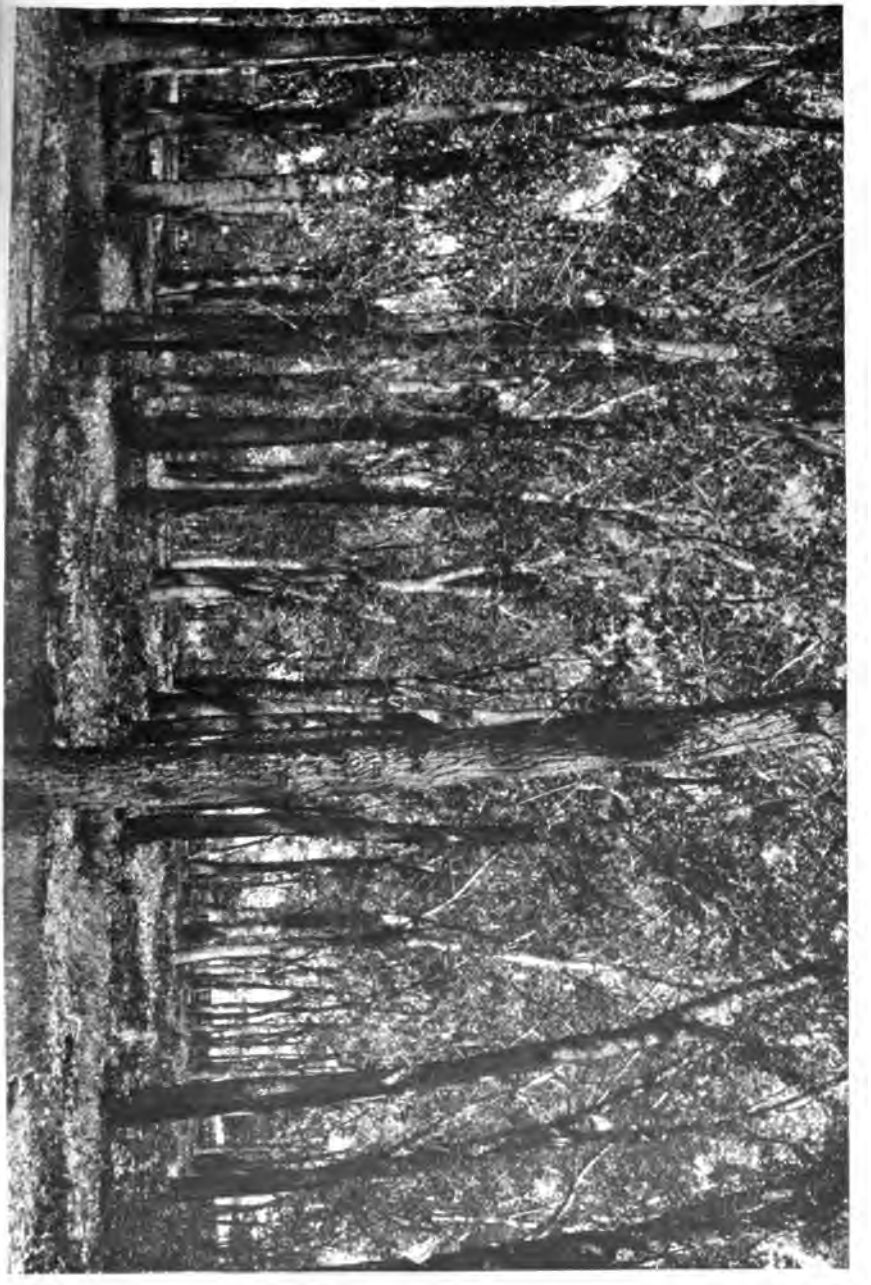
CONSTRUCTION.—There are many purposes on the farm for which wood materials can be obtained in the plantation. Posts and poles are in constant demand for the building of sheds and fences, forked timbers are often wanted for special uses, and there is continual need of miscellaneous pieces. All such materials play a part in the improvement of the farm and would cost considerable money if they had to be purchased.

It is difficult to estimate in dollars and cents the value of the planted timber from the standpoint of utility, because it is never possible to measure absolutely its benefits. Especially is this true of any region so deficient in natural timber as Nebraska. But could the real value be estimated, it would certainly be high, for the value of anything so influential upon the comfort and economy of the farm is very great.

COMMERCIAL VALUE OF PLANTED TIMBER IN NEBRASKA.

To a certain extent Nebraska farmers regard their plantations from the standpoint of utility, and are unwilling to cut and sell the timber products. However, experience has shown that for purposes such as fence posts, poles, and rough lumber, planted timber can be grown at a profit equal to that from agricultural crops on similar soil.

Cottonwood lumber from planted trees has been used extensively for dimension stuff and inside work in barns and sheds, being considered for such uses fully as durable as pine, while much cheaper. The prevailing price is from $13 to $15 per thousand feet. As indicating the returns to be expected from such an investment, Mr. R. M. Cole,



PLANTATION OF COTTONWOOD.

whose farm is situated 3½ miles southwest of Plattsmouth, has given the results from a 3-acre Cottonwood grove (see Pl. XII) planted in 1860. This grove was planted for general purposes. Its use for wind-break, shade, and ornament has fully repaid for the labor and cost of establishing it. Its commercial value, as represented in the following statement, is to be considered as additional to its utility value:

Results from a 3-acre Cottonwood grove planted in 1860.

Cost:	
Land, at $10 per acre	$30.00
Preparing land for planting	3.00
Seedlings	15.00
Planting	4.50
Four years' cultivation	30.00
Sawing 16,000 feet, at $7.50 per thousand	120.00
Total cost	202.50
Proceeds:	
80 cords wood, at $1.25 net	100.00
16,000 feet lumber, at $13	208.00
15 cords wood from tops, at $1	15.00
50 cords wood still standing, worth $1.25 per cord	62.50
Present value of land, at $60 per acre	180.00
Total proceeds	565.50

RECAPITULATION.

Total proceeds	$565.50
Total cost, exclusive of interest on investment	202.50
Net increase	363.00
Return less increased value of land	213.00
Net annual profit	5.32

The trees were planted 8 by 8 feet, and up to the time of cutting some firewood had been obtained from the broken limbs and dead trees. Use of the land for pasturage, Mr. Cole thinks, would offset the taxes. Part of the lumber was used to build a barn, the rest sold at the price given—$13 per thousand feet.

There are many instances, especially in eastern Nebraska, of Cottonwood trees in general-purpose plantations giving returns equal to or exceeding these when sawn into lumber.

As an illustration of the growth and products of Black Walnut as a planted tree, the grove of Mrs. Kiser, 3 miles southwest of Mynard, Cass County, may be mentioned. The grove, which is about 35 years old, and consists of 8 acres in the form of a shelter belt around the farmstead, was planted originally 8 by 8 feet. On account of thinning and the dying out of some of the trees, the stand has become irregular. The growth is also uneven, owing to inequality of the soil and to the pasturage of part of the grove. One-fourth acre of the

average and a similar area of the best trees were measured, and show the following averages:

Growth and products of Black Walnut, one-half acre.

Age.	Character of growth.	Number of trees.	Diameter breast-high.	Total height.	Length of bole.
Years.			*Inches.*	*Feet.*	*Feet.*
35....	Average, one-fourth acre.	59	9.6	40.9	20.2
35....	Best, one-fourth acre.	60	10.3	58.4	32.2

In the case of average growth, each tree would furnish, on an average, 12 posts, besides some wood. The 59 trees together would furnish 708 posts, worth, at 10 cents each, $70.80, an acreage value of $283.20. In the case of best growth, each tree would furnish 20 posts, with some wood. The entire quarter acre (60 trees) would furnish 1,200 posts, worth $120, giving an acreage value of $480. Enough wood has been cut to pay for the planting and cultivation, and the wood obtained from the remaining trees would pay for cutting the posts. The value of the posts, therefore, would be the net value of the grove. Per acre this value is, for the average part $283.20, and for the best part $480.

For post production other timbers, such as Black Locust, Hardy Catalpa, Red Cedar, Russian Mulberry, and Osage Orange are in many portions of the State more valuable than Black Walnut.

ESTHETIC VALUE OF PLANTED TIMBER IN NEBRASKA.

On account of its high value in general utility and commerce the planted timber of Nebraska has a good influence upon the social well-being of the State. It gives pleasure because it contributes so much to the comfort and prosperity of the people.

Nebraska farmers know that their pleasant home surroundings are largely the result of their own labors. They have changed the wild prairie into productive farms, and in the midst of barrenness have reared comfortable homes and surrounded them with trees, until the whole State is a picture of rural comfort. The beauty of the State, like its resources, has been developed by slow, painstaking work. It is inevitable that after creating so much of their State's value and attractiveness Nebraska people should be alert for its further development.

The planted timber contributes to the social well-being of the people also through the real pleasure it gives them. It benefits young and old alike. The children love the walnuts, the maples, and the elms that stand in their father's dooryard. They sport in their shade and clamber among their branches. Their fancy and aspirations are often stirred by their lofty tops as by nothing else. From the trees themselves more than from books or lectures the children learn the value

of forests. Nebraska children learn from these trees another important lesson. They see in their tree-protected homes the results of long-continued labor, and come to know the close relation that exists between intelligent work and well-being.

But the sense of pleasure and satisfaction from trees is not lost with the passing of childhood. It continues and increases with years. No one in Nebraska more fully enjoys his possessions than the man who can walk among his extensive groves of planted timber with his friends and call their attention to the many interesting facts connected with the growth of the trees and the methods of cultivation. To accompany such a man on a trip of this kind is a real delight.

GOVERNMENT INTEREST IN PLANTING IN NEBRASKA.

Each successful plantation in Nebraska by benefiting one portion has improved the entire region. The Government for this reason is interested in the promotion of individual planting until every landowner shall plant in quantity sufficient for his needs.

In Nebraska the Government has a further duty. In the State it owns 9,798,688 acres of land, the larger body of which centers in the region known as the sand hills.[1] Repeated trials have proved the sand hills unfit for any branch of agriculture except grazing, and for this purpose the sand hills proper do not have a high value. Coincident with the experiments which proved agriculture a failure for the region, other experiments and investigations have shown the natural conditions to be well suited to the growing of timber. Dr. Charles E. Bessey, who studied the region most thoroughly from the botanical standpoint, was one of the first to call attention to the possibility of foresting the sand hills. In his report to the State board of agriculture in 1892, he stated:

> During the year an investigation was made of the region in northern Nebraska known as the sand-hill country, in order to ascertain what native plants grow naturally upon the hills, and in the valleys, with especial reference to their value in supplying forage to domestic animals. The results of this investigation prove to be of unusual interest, showing us that in the sand hills we have a region quite unlike the remainder of the State in many of its physical features. The report made by Mr. J. G. Smith at once suggests the possibility of turning these hills and valleys to some better use than they now serve, and the probability that with some effort they might be covered with profitable forest growth. From all that I have been able to learn of the region, I am led to believe that it is possible to cover large tracts of this country with trees and shrubs, from which a good revenue might eventually be derived.

In the same report L. E. Hicks, geologist of the State board of agriculture, said:

> The foresting of the sand hills, if that shall ever happily be accomplished by combined and persistent effort of individuals, or by a liberal policy on the part of the National and State governments, will add a new artificial condition of considerable importance to the highly favorable natural conditions which already exist.

These opinions are approved by all who have studied the sand-hill

[1] Report of the Commissioner of the General Land Office, 1900.

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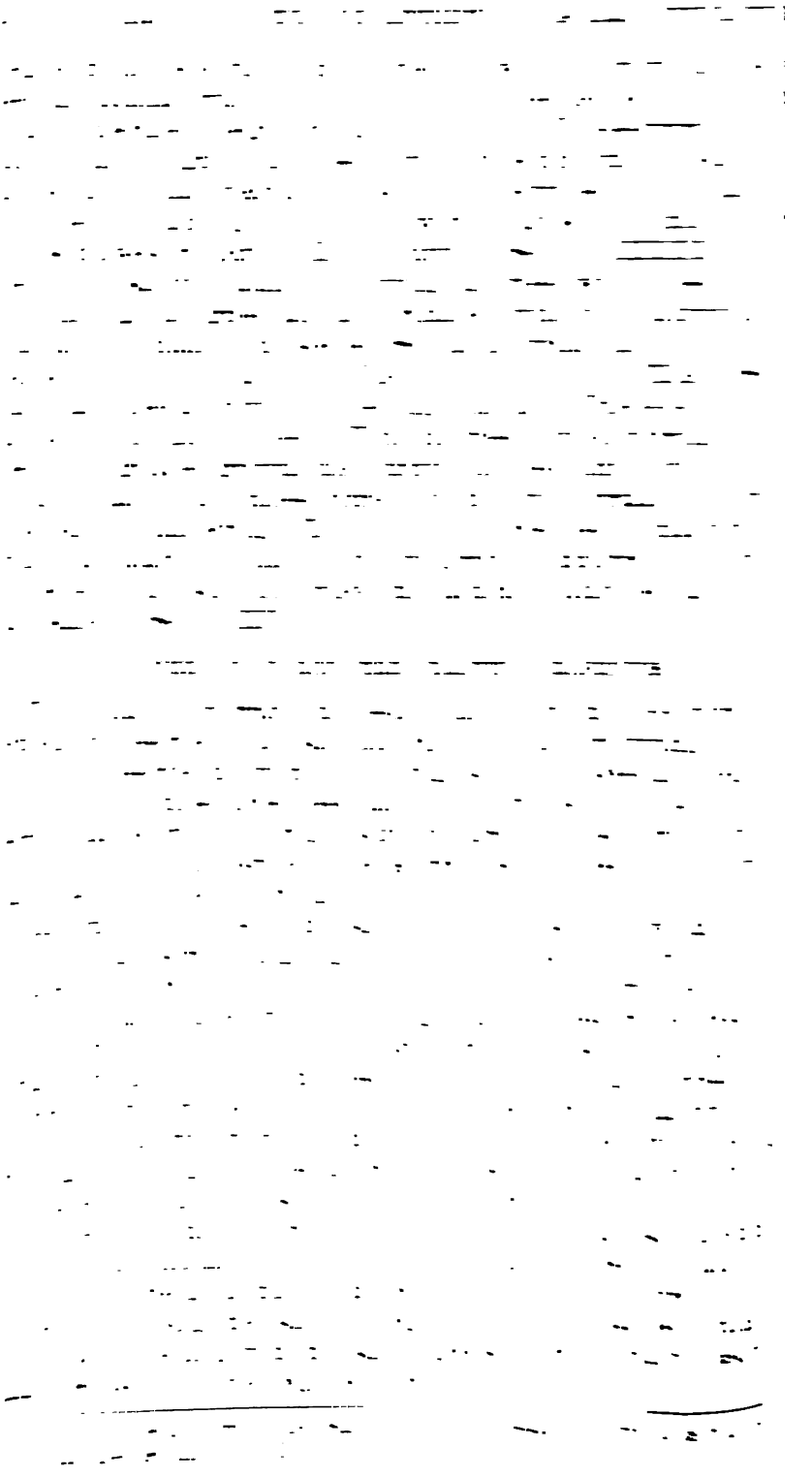

FIG. 1.—THE SAND HILLS.

FIG. 2.—PINE PLANTATION IN SAND HILLS, LOOKING NORTH. HOLT COUNTY, NEBR.

FIG. 3.—PINE PLANTATION IN SAND HILLS, LOOKING WEST. HOLT COUNTY, NEBR.

FIG. 1.—YOUNG YELLOW PINE ENCROACHING UPON A SAND HILL. SHERIDAN COUNTY, NEBR.

FIG. 2.—YOUNG PINES ENCROACHING UPON A SAND HILL. DAWES COUNTY, NEBR.

L. Howard.

A WORKING PLAN FOR SOUTHERN HARDWOODS, AND ITS RESULTS.

BY

JOHN FOLEY,

Field Assistant, Bureau of Forestry.

[REPRINT FROM YEARBOOK OF DEPARTMENT OF AGRICULTURE FOR 1901.]

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A WORKING PLAN FOR SOUTHERN HARDWOODS, AND ITS RESULTS.

By JOHN FOLEY,
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INTRODUCTION.

One of the greatest strides in the progress of forestry in the United States was made when the Bureau of Forestry undertook, three years ago, "to provide a series of practical examples of improved treatment of private forest lands, in which the present interest of the owner and the protection and improvement of the forest shall have equal weight." Such examples are the best answers to the general question as to how far the private owner may practice forestry. The idea is to assist farmers, lumbermen, and others in the various sections of the country in applying improved methods of handling their forest lands, then to publish the methods and results of the plans likely to be of the most general interest and application.

A typical instance of the examples established by the Bureau of Forestry is found in the preparation and execution of a working plan for conservative lumbering on the tract of The University of the South, at Sewanee, Tenn. This paper is intended to merely review the main considerations in the management of this tract, the broader principles of the working plan, and the principal results. A complete description of the tract and its treatment will be prepared for publication as a bulletin of the Bureau of Forestry.

DESCRIPTION OF THE TRACT AT SEWANEE, TENN.

The University Domain surrounds the town of Sewanee, and comprises 7,255 acres, of which 6,555 are wooded. The remainder of the area is cleared or occupied by buildings. The domain extends over a considerable portion of the Sewanee spur of the Cumberland Plateau, and includes two very distinct types of land; 5,765 acres lie on the rolling table-land of the plateau, while 1,490 acres cover the steep slopes of the coves which cut into it. The elevation varies from 800 to 1,900 feet above sea level. Sandstone and limestone are the principal rocks. The limestone outcrops in the coves up to 1,850 feet, where it is topped by sandstone, the surface rock of the plateau. The soil of the plateau is a loamy sand of poor quality, very loose, and of slight depth. The clay of the coves is of considerable fertility, owing to the admixture with it of limestone.

THE FOREST AT SEWANEE.

The differences in the forest at Sewanee are as marked as those in the topography and soil. The coves are in practically a virgin state. Their slopes are clothed with a fairly dense stand of tall, straight, large-sized trees. Most of these are old, and some of them are so overripe as to be decaying. The important species represented are Black Walnut, Shagbark, Pignut, White Oak, Chestnut Oak, Red Oak, Tulip-tree, Black Cherry, and White Basswood. (Pl. LXV.) The plateau, however, is clothed with an open growth of poor specimens of the inferior species. Occasional large Tulip-trees, Chestnuts, and White Oaks indicate what formerly was there; but at present, owing to indiscriminate cutting, grazing, and repeated fires, the plateau woodland is composed mainly of sprouts and low-crowned trees of good size which have been rejected or overlooked in past lumbering. (Pl. LXVI.)

From this hasty survey of the forest conditions at Sewanee it is evident that two very distinct types of forest are represented and that their treatment must be very different. It is this combination of two very common classes of forest land which makes the experiment at Sewanee of especial interest and value. The cove forest corresponds to the tracts of virgin timber which have remained untouched on account of their distance from market or for some other reason. The plateau woodland is typical of the woodlots in the older sections of the country, where the demand for timber has been great and where it has been cut without regard for another crop. The forest in the coves is far from being in as good condition as it might be. The majority of the trees have reached their prime and their growth is very slow. They monopolize room and light needed by younger vigorous specimens. Many of them are of valueless kinds. Such forests require regeneration. It is necessary that the older trees be removed in the proper places and in sufficient numbers to give the small trees of the desirable species a chance to develop. The removal of the undesirable species also prevents their seeding the openings to their own kinds. The aim should be to have in the forest only species of value and none but thriving specimens of these. The treatment of the plateau should have the same object in view. But considerable improvement in the composition of the crop is necessary before this woodland can be said to approach good forest conditions. The larger part of it is composed of crooked, unhealthy sprouts. Many fire-hollowed trees are overtopping young growth. Red Maple, Black Gum, Sourwood, and Mountain Laurel should be got rid of, as they occupy space better occupied by more valuable species.

TREATMENT OF THE FOREST AT SEWANEE.

It is seldom very difficult to determine the treatment necessary to improve the forest. The trouble comes in adjusting these measures

FIG. 1.—VIEW OF COVE FOREST FROM PLATEAU.

FIG. 2.—INTERIOR VIEW OF COVE FOREST.

FIG. 1.—REPEATEDLY BURNED PORTION OF PLATEAU.

FIG. 2.—CUT-OVER AREA ON PLATEAU.

to the wishes of the private owner. He may need a certain amount of money at a certain time, his land may be located where a certain kind of forest produce is of more value than any other, or he may own a mill which he wants to keep going at a certain rate.

In the case under consideration, The University of the South needed money; it wanted as much as it could get, and it did not want to spend any on forest improvements, no matter how profitable they might be in the long run. Thus, a working plan to be acceptable to the university had to provide for good financial returns, and on the other hand, in order to comply with the requirements of the Bureau of Forestry, it had to provide for leaving the forest in better condition than before.

The market for logs, ties, and cordwood is good at Sewanee, and thus was removed one of the greatest and most usual hindrances to the practice of forestry by private owners, namely, the difficulty of selling forest products profitably.

After the value of the timber and the cost of removing it had been thoroughly studied, it was ascertained that by judicious selection of the trees to be cut, so as to favor the reproduction and growth of the desirable species, and by avoiding damage to the small growth and waste in the sawing of timber, it would be possible to improve the character and composition of the Sewanee forest while making it yield a profit to the university. Sawlogs, ties, and firewood are materials through the harvesting of which the improvement of the plateau woodland was to be sought, while sawlogs alone were to be cut in the coves, owing to the higher cost of logging there. No work could be done which would not give sufficient returns to at least pay the expense of the same.

LOGGING THE SEWANEE TRACT.

In accordance with this scheme, enough timber for a year's logging was marked in Hawkins Cove. Tulip-tree, oak, hickory, Cucumber-tree, White Ash, White Elm, and Black Walnut were the species which could be sold. All dead, diseased, overripe, or decrepit specimens of these species which contained enough lumber to repay the cost of removing them were marked for cutting. So were merchantable trees which were suppressing promising young growth. Exceptions to this general rule were made when trees otherwise fit to cut were needed as seed trees, owing to the lack of smaller seed-bearing specimens of their kind. Due consideration was given to the heavy fruit of most of these species, which restricted their seed distribution to the immediate vicinity of the parent tree. The relative demands upon light of the different species influenced the selection considerably, for it would have been useless to leave a Tulip-tree to propagate itself where surrounded by a dense growth of oak and hickory saplings, as the seeds of this species will not germinate except in openings where there is very

little shade. This intolerance of shade is characteristic of Tulip-tree throughout life; it succeeds only when its crown is above those of its companions. This is true in various degrees with other species; some will germinate in shade, but demand sunlight later, others reverse this order. A knowledge of the habits of trees in these respects is therefore very necessary to good results from conservative logging.

On the plateau, trees were marked only where their removal would not expose the already poor, dry soil to the further action of the sun and wind; again, only trees worth more at the time of cutting than they would be in the future were chosen. (Pl. LXVII, fig. 1.) The species favored in the selection of seed trees were Tulip-tree, White Oak, Scarlet Oak, Pignut, and Yellow Oak.

The cutting of logs and ties on the plateau was contracted for under the following rules:

(1) Only marked trees shall be cut.

(2) All marked trees shall be cut, unless a reason satisfactory to the inspector is given for leaving them.

(3) Except in cases of hollow or dote, no stumps higher than 1 foot above the ground shall be cut.

(4) Care shall be taken not to injure young growth while felling, cutting, or hauling the timber.

(5) As much as possible of each tree shall be cut into logs 2 inches longer than the lengths called for by the mill.

(6) The logs cut shall be well butted and hauled to the mill.

(7) Such White and Chestnut Oak trees and parts of trees as will not yield sawlogs shall be cut into as many railroad ties as is possible.

(8) Every effort shall be made to extinguish any fire which may be seen.

In order that the utilization might be as complete as possible and to reduce the amount of combustible material on the ground, the cutting for firewood was to be restricted to the tops of the trees cut on the plateau. The following rules were to govern this work:

(1) No standing trees, living or dead, shall be cut for any purpose whatsoever.

(2) Care shall be taken not to injure any standing trees while cutting and hauling the firewood.

(3) As much as possible of each tree shall be taken.

(4) Such portions of each tree as may be left shall be scattered about, not piled in heaps.

(5) Every effort shall be made to extinguish any fire which may be seen anywhere.

PROTECTION OF THE SEWANEE FOREST.

The insertion of a fire rule in each of the logging contracts indicates the extent to which the working plan concerned itself with this most serious menace to forest preservation and management.

At Sewanee, as in most small Southern communities, the ranging of cattle and hogs in the forest is customary. Since the mat of litter which forms under natural forest conditions prevents the growth of grass and affords a hiding place for nuts, it is burned away by the owners of horses, cows, and hogs, and by gatherers of nuts. The

FIG. 1.—TREE MARKED FOR REMOVAL IN IMPROVEMENT CUTTING.

FIG. 2.—APPEARANCE OF COVE FOREST AFTER LUMBERING.

harm done by the animals themselves through eating and trampling young growth, and by consuming the seed upon which the reproduction of the Chestnut, Pignut, and oaks depend is considerable, but this burning, which is repeated every spring and fall, is disastrous. The humus, the most important factor in soil quality, is destroyed, and the soil thus bared is left to heat, freeze, and dry out to a great depth. Small trees are killed outright. Many of the latter sprout from their roots again, but the new growth is of poor quality and makes slow progress. The large trees are injured at their bases and rot results.

Other causes of fire in the forest at Sewanee are locomotives and careless visitors, but the majority of the fires are set with a view to improving the grazing.

Without a costly patrol, it is almost impossible to prevent fires. The principal hope lies in the realization by the farmers that the practice of burning off the humus is injurious to the land in the long run. In order to prevent the spread of the accidental fires which will occur now and then, the working plan for the University Domain advised the carrying on of work in the woods during the dangerous seasons especially and the adaptation of roads to the uses of fire lines.

A good many trees have been cut every year without the knowledge of the university. Tenants have not confined themselves to their leases, and people from without the tract often appropriate timber to which they have no right. A closer watch by means of a patrol was recommended to guard against this enemy of profitable forest management.

RESULTS OF THE WORKING PLAN AT SEWANEE.

The logging of the tract at Sewanee has been going on since July of last year, and the work, which has been carried on according to the methods above outlined, has been a pronounced success in every way. The university is perfectly satisfied with the financial returns. It had nothing to do but to contract with a mill man for the purchase of all the marked timber and with a lumberman for getting it to the mill, which the purchaser of the timber found it to his interest to erect at Sewanee. The clear profit to the university, without its having to engage in any of the details of the business, is shown in the following table:

Net returns from logging the University Domain from July, 1900, to May, 1901.[1]

COVE TIMBER.

Grade.	Tulip-tree.	Oak.	Hickory.	Bass-wood.	Black Walnut.	White Ash.	All species.
First grade	$570.98	$124.52	$185.40	$10.46	$10.51	$9.13	$911.00
Second grade	214.55	33.07	18.16	4.54	13.67	25.11	309.10
Third grade	19.58	.....	.....	.....	2.38	10.58	32.54
All grades	805.11	157.59	203.56	15 00	26.56	44.82	1,252.64

[1] At least three months' work remains to be done.

Net returns from logging the University Domain from July, 1900, to May, 1901—Cor

PLATEAU TIMBER.

Grade.	Tulip-tree.	Oak.	Hickory.	Bass-wood.	Black Walnut.	White Ash.	A spec
First grade			$1.40				$
Second grade	$39.69	$13.83	.27				
Third grade	6.78						
All grades	46.47	13.83	1.67				

ALL GRADES.

Cove	$805.11	$157.59	$208.56	$15.00	$26.56	$44.82	$1,25
Plateau	46.47	13.83	1.67				6
Total	851.58	171.42	205.23	15.00	26.56	44.82	1,314

The lumberman, like nearly all lumbermen, at first looked askan at the rules to govern his work and raised his price for the job, becau he felt sure these rules would increase his expenses; but he was agre ably surprised at the results. He and his crews found that the require stump height was not a trying one to adhere to, and that the satisfa tion of putting the trees where they wanted them and leaving th woods in presentable condition more than made up for the little tim and trouble required to fell trees away from young growth. That h found his profits in no wise curtailed may be taken for granted from th fact that he is anxious to get the contract for the next year's logging and that his bid for the work is comparatively lower than for his firs work.

The Bureau of Forestry is satisfied because it has demonstrated tha a happy medium between forestry and lumbering can be struck. Had the University Domain been logged as it would have been ordinarily, the money returns would have been no greater. The chances are that they would have been less, for the little or no care taken in felling would have resulted in waste due to many shattered, splintered trees.

The condition of the forest after lumbering is the principal concern of the Bureau of Foresty. The present state of the logged area at Sewanee is all that was expected. The contractor followed his instructions carefully, with the good result of cutting only the proper trees and reducing damage to young growth to a minimum.

The consequence is that to-day there are plenty of vigorous small trees in Hawkins Cove given a new lease of life owing to increased light and growing space. (Pl. LXVII, fig. 2.) Reproduction of the best kind has taken place, even Tulip-tree, White Ash, and White Elm being found along the logging roads and skidding paths.

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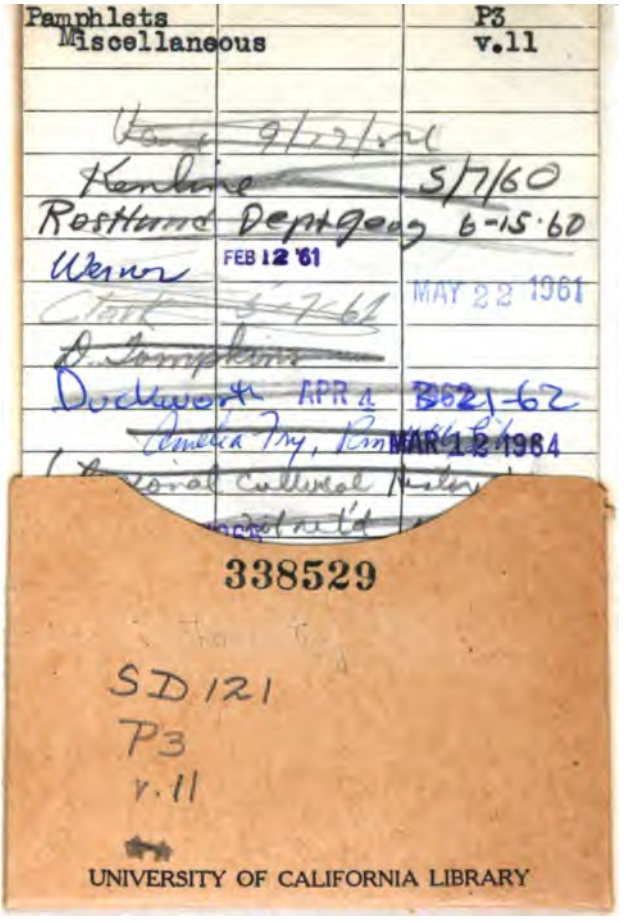
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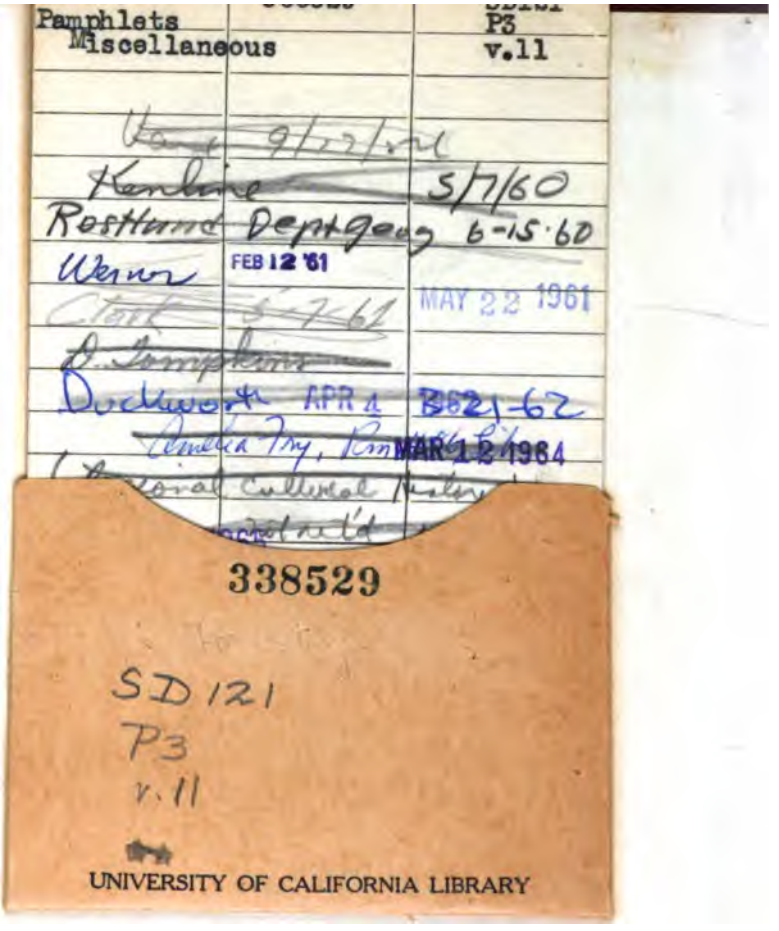
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